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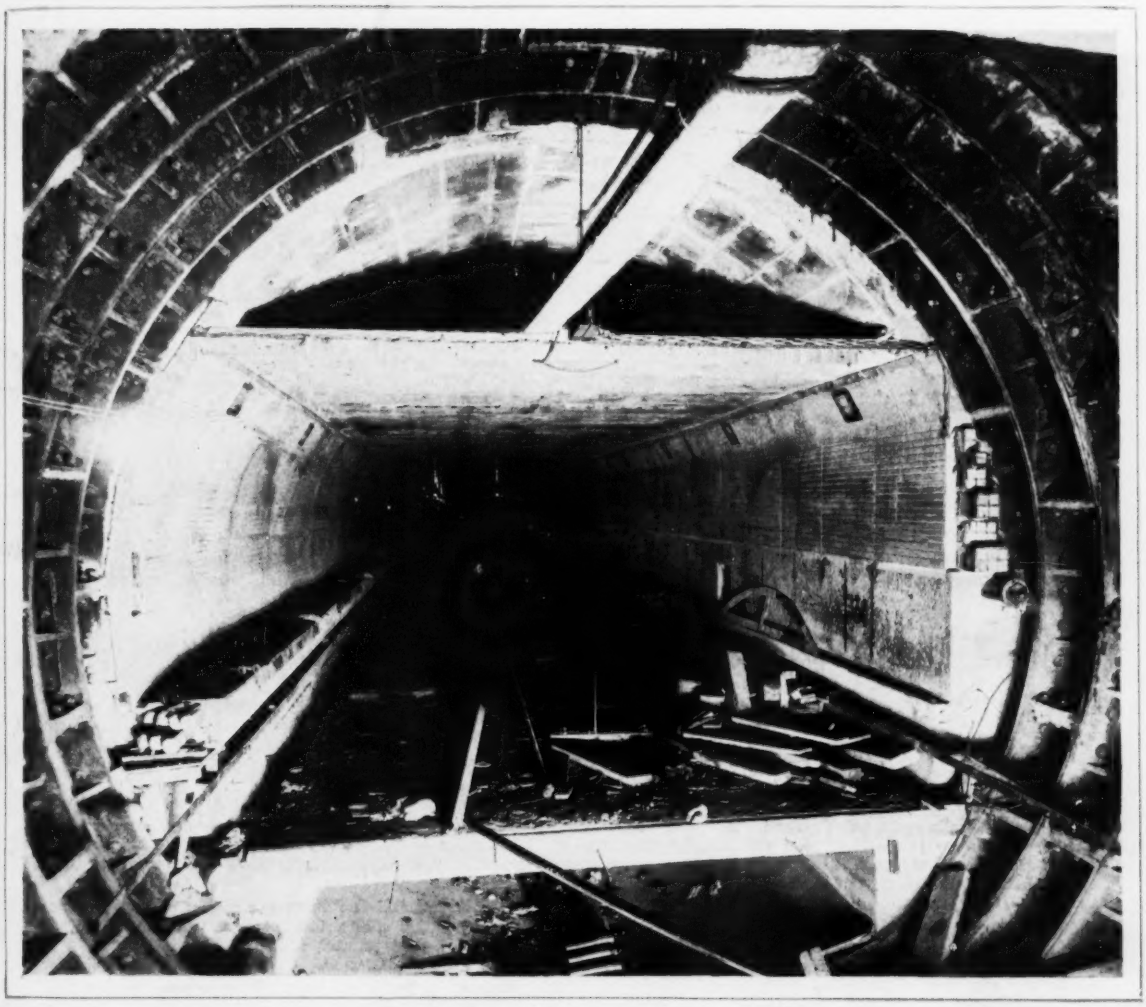

Holland Vehicular Tunnel, New York.
Details of the Concrete Lining.

First of a Series of Articles on Highway Progress in the South Atlantic and Gulf States: South Carolina — Lining Procedure in the Holland Tunnel — Fifth Article on Principles of Soil Mechanics: Comparisons of Sand and Clay — Engineering News-Record Statistics of the Construction Industry

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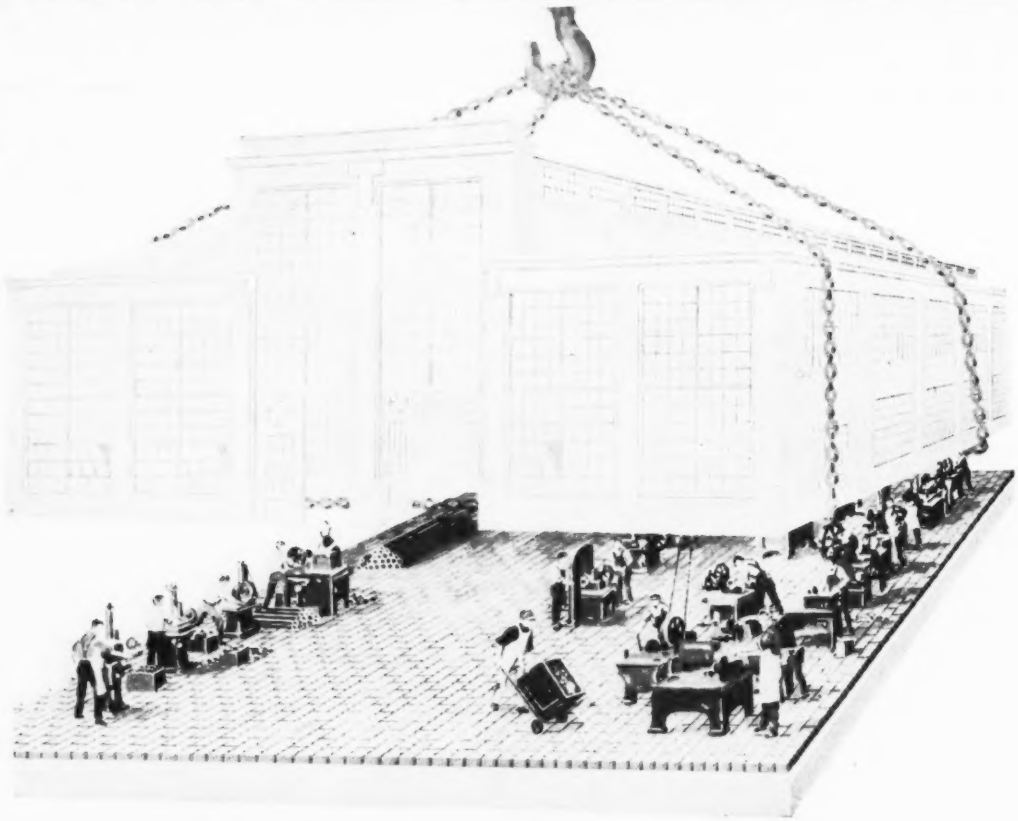

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DEVOTED TO CIVIL ENGINEERING
AND CONTRACTING

FRANK C. WIGHT
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Distribution Economies Lag

SECRETARY Hoover's annual report, just issued, gives some figures which the President quoted in his speech in New York two weeks ago as evidence of the country's growing prosperity. These figures do this but they are not as true an index as they might be and in addition they reveal, by omission, one of the defects in our industrial system. The Secretary says that whereas wages had risen from 100 per cent above pre-war level in 1920 to 120 per cent above in 1925, wholesale prices had declined from 120 per cent above pre-war level in 1920 to only 57 per cent above in 1925. Both the President and the Secretary use these figures to show that prices are going down and wages going up, or in the words of Mr. Coolidge, "the wage-earner receives more, while the dollar of the consumer will purchase more." The argument is weakened by the use of wholesale prices as an index of the consumer's purchasing ability. Unfortunately the wage earner does not buy from the wholesaler, but from a retailer between whom and the wholesaler there are numerous operations that tend to raise prices, or at least to prevent that ready reaction to the major influences that govern production cost. Thus we find the National Industrial Conference Board reporting that in October, 1925, the cost-of-living index, which is the measure of retail prices, was 70 per cent above pre-war, as against 105 per cent above in 1920, the peak. In other words, although wholesale prices at the peak were relatively higher than retail prices the drop in wholesale prices since then has been nearly twice the drop in retail or, in percentages, 29 as against 17. Engineering methods are beginning to show in production but distribution, the link between producer and retailer, still awaits the engineering touch.

Southern Road Progress

HIGHWAY development in the southern states has been a struggle against the tradition of local rights. Apathy, intolerance, slack industrial growth, primitive habits, all alleged, and all in some measure responsible for, backwardness in highway improvement, have been less sturdy forces to overcome than the almost religious belief of the people in the absolute right of the local units of government even to the smallest to spend their money uncontrolled and to build and keep their public roads as they chose. The articles on highway progress in the South which begin in this issue are remarkably explicit in disclosing the ancient strength of local rights in road development and their still strong resistance to any centralization of administration in the state and federal governments. But it is shown quite as explicitly that a break in this resistance has come and that it is the pressure of engineering conviction and control which has caused the break. Previously, with only a semblance of state control, the states whose highway work is being reviewed were given highway commissions and highway systems by the Federal Aid Law of 1916. This furnished engineering its basis for an offensive and in the years since, engineers for the states and for the federal government have advanced a little further each year to the present position of improved highway administration in the South. The accomplishment is one in which engineering can justly take pride. It is set down clearly in the series of studies which begins in this issue.

Unscientific Government

IN THESE days when we hear so much about the necessity of putting government on a business basis, which in the minds of those who shout loudest for such a consummation means to put a business man in office, it is refreshing to read some plain talk which exposes some of the fallacies of this popular view. Such talk makes up the whole of a commencement address by Prof. William B. Munro, of Harvard, just published. One quotation will suffice to show that one expert on government at least does not accept the current patter, but realizes that there is a science of government which requires a special training. "Were I to go out upon the street this afternoon," said Professor Munro, "and say to the first man I meet, 'Here, you, make me a pair of shoes,' he would look at me in amazement and reply, 'You're mistaken, sir, I'm not a shoemaker; I don't know the first thing about making shoes; go to a shoemaker.' 'Oh, that's all right,' I would say, 'all men are equal in this community; you are just as good as any other citizen: you are entitled by the constitution to make shoes or any other commodity.' He would probably wonder how I escaped from the psychopathic ward. But suppose this same man in the street were asked to become city manager of Pasadena. Would he display any such modesty or reluctance? Not a bit of it. He would throw out his chest and say, 'I'm your man.' Then he would call in the reporters and say, 'I'm going to put this city's business on an efficiency basis, reduce taxes, and make everybody happy.'"

More Stone in Concrete

IN AN editorial on "Simplifying Concrete Proportioning" in the issue of Oct. 22, p. 661, one word was miswritten, which may give some misconception of the principle stated. In the second column, second paragraph, in commenting on the new proposal for concrete proportioning, it was stated that in this new method the engineer "merely specifies a water content to guarantee the desired strength and lets the contractor put as *little* stone as he can actually work with in such proportioning as to insure this workable mixture." The word *little* should have been *much*, as the context of the rest of the editorial indicated. The theory is simple, namely that strength is guaranteed by a proper water-cement ratio, provided the concrete is workable.

That being the case the engineer specifies the amount of cement and water and inspects the workability. The contractor, to save money, must use as little cement, his high priced material, as possible which means he must use as much aggregate as the proper workability permits. The word "little" in the earlier note, then, referred to cement and not to stone as it was inadvertently written.

Pennsylvania Against New Jersey

AT LAST the dispute over toll collection on the Delaware River bridge has been taken to court. The state of Pennsylvania has gone to Washington and asked the Supreme Court to compel New Jersey to help finish the bridge without waiting for a toll agreement to be reached by the two states. As the case is to come to a hearing soon and will probably be decided within a few months at the most, work on the bridge will not be measurably delayed. On its face, therefore, the case is of interest only to lawyers and jurists. This would be a narrow view. The case bears very directly on future practice in constructing public works capable of self support. Projects to build such works and carry them on their earnings are constantly under attack from those who for reasons of self-interest would have the cost burden laid in the general tax roll. Public toll-bridge construction has come into use against the force of such hostile influences, as a valuable means of economical financing and speedy construction of much-needed river crossings. It has had to contend also with the opposition of persons interested in private toll-bridge construction. Public bonds issued on the security of tolls have the advantage of cheapness over similar private bonds, and have the advantage over general tax bonds that they do not swell the tax roll but are paid from service charges. These advantages were of decisive influence in making the Philadelphia-Camden bridge possible, as the enterprise is one which private capital would have been reluctant to attempt, and one which the voters of New Jersey would almost surely have declined to authorize on the tax-bond basis. If the outcome of Pennsylvania's attempt to outwit the New Jersey taxpayer succeeds, future public toll-bridge proposals will not have an easy time of it, in New Jersey or elsewhere. And this would mean—at least now, when tax increases and large bond issues are having a hard time of it everywhere—dependence on private toll-bridge enterprise or else a long wait for some important bridges.

Concrete Paving Studies

A STUDY of efficiency in road construction comparable in importance with its earth moving investigations of 1924 has been completed this year by the Bureau of Public Roads. This latest investigation has been into the practices of concrete road building and the first article reporting results appears in *Public Roads* for November. The report is written by J. I. Harrison who directed the road grading studies of 1924, and in his first article he makes statements which challenge the pride of contractors for concrete roads. There are few concrete paving projects, he reports, on which the daily output cannot be increased 25 per cent. And mixer troubles, he says, may easily cause a loss of $2,000 to $4,500 a season. This hits the equipment manufacturer. Nor does the engineering direction escape censure. Arbitrary interference by inspectors and abuses of discretionary clauses in specifications cause considerable loss to the contractor on at least half of all operations. These are shock punches to our complaisancy as builders of paved roads, and we may not easily shake them off. The articles by Mr. Harrison give the evidence of explicit figures. Moreover he has clinched the evidence by taking over the management of some of the operations criticised and raised the efficiency and reduced the troubles without going outside the original outfit and organization on the job. There may be things in the report which contractors and equipment makers may dispute but no one of them can afford to ignore the findings as they are summarized in the first article and will be developed in succeeding articles.

Utilizing the Obsolescent

OBSOLESCENCE does not always mean scrapping. Even though a new process may be substituted for one outgrown by changes in an engineering art adaptation of the old structure to the new process may be possible. This is well illustrated by the sewage-works for the 26th Ward of Brooklyn Borough, New York City, the conversion of which from a chemical precipitation to a fine-screening plant was described in our issue of Nov. 26, p. 864. In this case the circular form of the old tank, with its concentric channels, made it quite readily adaptable to the placing of revolving inclined-disk screens and the bar screens which preceded them. How readily this was effected is apparent from the sectional plans on facing pages in the issue named.

In the thirty years since the original 26th Ward plant was built there has been as notable a change in structural material for sewage-works as in sewage treatment processes. Brick was used, for the old walls of the tank were of brick and the floors of plain concrete. Such new walls as were built in the reconstruction were of reinforced-concrete, which material also replaced the old plain concrete floors. It is worth noting that the three-decade-old foundation of the old plant serves equally well for the new, again confirming past experiences with piles in saturated ground. The roof, also, appears to serve the new plant as well as it did the old. As a whole, the reconstruction job deserves consideration in these days of change in arts and customs during an era of high prices and postponed construction. How much was saved in the Brooklyn case as against building an entirely new structure for the fine screens and their accessories and whether any of this will have an offset in increased operating charges it would be interesting to know.

The obsolescence of the process used at the 26th Ward sewage-works is one of the most interesting features of the history of sewage treatment. Not only has the so-called Powers process or variant of chemical precipitation passed out of use but, broadly speaking, the use of chemical precipitation of any sort of municipal sewage. Sedimentation alone, with sludge digestion in one-story or two-story tanks or the separate sludge digestion tanks early tested at the Lawrence experiment station, used on a large scale at Birmingham, England, and Baltimore, Md., and apparently growing in favor of late, together with the activated sludge process on the one hand and fine screening on the other have left chemical precipitation high and dry.

A Public Liability

ORDINARY beliefs that public boards and commissions serve the interests of the public continue to be laughed to scorn by the well known Passaic Valley Sewerage Commission of New Jersey. The latest development in the checkered history of that body again presents the question whether it is safe to have financial or other dealings with a board or commission.

A year or more ago, several contractors who sued the commission for damages caused them by the commission's misrepresentations, won their suits in decisive style, and were awarded large sums in damages. The commission did not pay, however, but appealed. The contractors won again, just as emphatically, but still did not collect. They obtained judgment against the commission, but the judgments were returned unsatisfied. The commission made public plea that it had no money with which to pay the judgments.

About the same time however, it made clear that it did not intend to pay, by asking the Supreme Court of the United States to review the findings of the lower courts. As we understand it, a Supreme Court procedure is by no means inexpensive; in spite of its plea of poverty the commission seems to have found money enough for this purpose. Last week, finally, the high court refused to take up the case. At this stage, one would think, the commission, which in the last analysis merely represents the citizens, must surely act as any citizen would, namely, proceed to pay the sums awarded against it. But no—according to recent statement as published in the Newark *News*, the commission "has gone as far as it can under the present situation, and the next move possibly will be made by the contracting company." A truly refreshing game of Now It's Your Move! If a private individual undertook to resort to similar dillydallying with rights and equities he would long since have found himself in difficulties. But a commission evidently may be quite devoid of that conscience and proper respect for consequences which tends to guide the individual's acts.

This particular commission is a state body, but apparently the state government of New Jersey admits no responsibility for the commission's financial dodging or its confession of bankruptcy. On the other hand, the municipalities whom the commission contracted to supply with outfall-sewer facilities would, we think, be quick to resent the imputation that they themselves are lacking in business honor—that the commission's acts are theirs, or that they are trying to evade just debts. The fact of the matter is that the state, which created the commission, constructed an irresponsible machine, of notable inefficiency and obstructiveness; and yet neither the state nor the communities for whose service this machine was created would now be willing to take the blame for its acts. Nor do we believe that even the members of the commission would in their private affairs resort to such acts as in their organized status they have indulged in. The case seems to be one of a grotesquely distorted notion of what constitutes public service.

If the conduct of public work by commissions and boards leads to such a result, then let us have no more of it. On the present showing it is highly unsafe to have financial or contractual dealings with an irresponsible public body. Whoever is interested in efficient conduct of public affairs may well note the history of this commission as a powerful reason for keeping public life clear of similar delegated governments in future. They bring public service and public contracts into disrepute. And for this the citizen pays, in the end.

Design Not Invention

THOSE engineers who feel disposed to patent certain novelties which they have devised in the structural field will do well to consider the decision of the United States Supreme Court made some weeks ago in the concrete chuting patent case. That patent was applied for in 1908 at a time when apparently nothing of precisely this nature had been patented. The Supreme Court, however, has upheld the decision of a lower court that the combination described in the patent does not constitute an invention because there were in existence at that time numerous devices for the handling of other materials so similar to that devised for the then novel "wet" concrete that it took only the application of engineering ingenuity to adapt these devices for this particular use.

The decision says: "To say nothing of the universally known methods and appliances for raising and distributing water, there were ready at hand widely used and generally understood appliances for the elevation and distribution of mobile substances, such as grain and coal, which involved, both in principle and in practical detail, all the elements described in the claims. Failure to make use of these obviously applicable methods and appliances in combination, suitable to the particular work in hand, in dealing with a new plastic material capable of similar treatment would, we think, have evidenced a want of ordinary mechanical skill and of familiarity with construction problems and methods. The adaptation independently made by engineers and builders of these familiar appliances to the movement and distribution of wet cement in building operations and the independent patent applications, within a comparatively short space of time, for devices for that purpose are in themselves persuasive evidence that this use in combination of well-known mechanical elements was the product only of ordinary mechanical or engineering skill and not of inventive genius."

The court therefore holds with the earlier decision that such devices, though they be in themselves novel, result from group consciousness and not an individual consciousness, that they are "the suggestion of that common experience which arose spontaneously by a necessity of human reasoning in the minds of those who had become acquainted with the circumstances with which they had to deal" and that their so-called invention "is but the display of the expected skill of the calling and involves only the exercise of the ordinary faculties of reasoning upon the materials supplied by a special knowledge, and the facility of manipulation which results from its habitual and intelligent practice."

The principle thus laid down is an old one. It is too frequently forgotten by amateur inventors who, hitting upon some admittedly novel arrangement of old details or by stepping a trifle forward from the accepted practice arrive at some device, machine or structure which they consider worthy of patent and thereby of monopoly control. They should consider in the light of such a decision whether what they are attempting to do is more than the application of mechanical skill in the course of a natural development and expansion of the art, or else they are apt to find that their expenditure for patenting the device is a waste of energy and money.

Lining Procedure in Holland Vehicular Tunnel

Both Concrete and White Glazed Wall Tile Used—Concrete Poured in Seven Stages Because of Many Built-in Structures—All Metal Trim of Bronze

CONSTRUCTION work on the Holland Vehicular Tunnel under the Hudson River between New York and Jersey City has again reached a point where a recounting of developments may be made. The completed major divisions of the project have been described in *Engineering News-Record* as follows: Feb. 19, 1920, p. 357; Apr. 6, 1922, p. 574; Feb. 8, 1923, p. 242; May 8, 1924, p. 798. Before completing the work there remain the finishing operations incident to lining first with concrete and then with a special glazed tile; the paving of the roadway (*Engineering News-Record*, Oct. 25, 1925, p. 726), the construction of the ventilation buildings, the installation of the pumping machinery at the drainage collection points in the tunnel and the preparation of entrance and exit plazas at both the New York and New Jersey ends. The present article describes the finishing work in lining with concrete and tile.

A concrete lining covered with glazed tile on the walls is being placed in the tunnel. Although the concrete lining is practically complete, work has only recently been begun in placing the wall tile. Concreting has proved a very exacting procedure on account of many built-in structures. The contract for furnishing and placing the tile includes also the erection of all the metal frames and doors that are required to cover the various niches in the concrete walls for such accessories as lights, telephones, fire extinguishers and pumps. Practically all of this metal work is of bronze construction. The finishing operations in the tube and steel bent sections (Fig. 1) are somewhat different, but practically identical shapes of tunnel will finally result consisting of a granite block roadway, tiled walls and a concrete ceiling. Air ducts of circular section below the floor and above the ceiling will obtain in the tube section, while these are rectangular in shape in the steel bent section.

As finally built, the Holland Tunnel is 9,250 ft. long between grade points. It consists of twin-tubes of cast iron and of steel-bent subway and open-cut approaches. The tube section is made of bolted cast-iron rings (cast-steel near the shafts) 29½ ft. in diameter and 2½ ft. wide. Each 2½-ft. ring in turn is composed of 14 segments each approximately 6 ft. long and a 1-ft. key section; all joints are made tight with high tensile steel bolts and finally calked with ribbon lead. The steel bent sections are of conventional column and girder design.

Concreting Procedure—On account of the variety and number of structures that form integral parts of the concrete lining, it was necessary to pour the concrete in seven stages. This necessitated the use of six different sets of forms, as shown in Fig 2. Form 3 was used to place two stages of concrete on the sidewalk side. Nearly all the concrete has been poured, no compressed air being used except for necessary grouting in the upper arch. The description of the concreting procedure will be confined to the tube section since no distinct methods were used in the steel-bent section of the tunnel. In fact, there was much less concreting necessary in the latter part since hollow tile curtain walls were erected between the wall columns instead of using concrete walls as in the tube.

A central mixing plant at each river shaft provided concrete for the operations that started in the center of the river and advanced in both directions—always

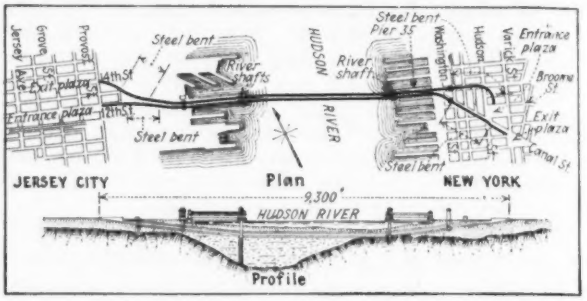


FIG. 1—PLAN AND PROFILE OF HOLLAND TUNNEL

working toward the source of material supply. Since the mixing plants at each river shaft were practically the same, the one in the New York shaft only will be described. As shown in Fig. 3, this plant was really composed of two complete mixing units, one for each tunnel. Gravel and sand were handled from scows into the storage bins by clamshell buckets. The bins holding 390 cu.yd. of gravel and 245 cu.yd. of sand, respectively, fed through a heavy cast-iron pipe to the 20-S mixers below. These mixers were mounted on platforms supported by wooden staging and were located approximately at the top of the tube sections where they enter the shaft. The lower sections of the aggregate feed-pipes, comprising a volume equal to the required mixer charge for 1:2:4 concrete, were shut off from the upper part of the pipes by slides; a measur-

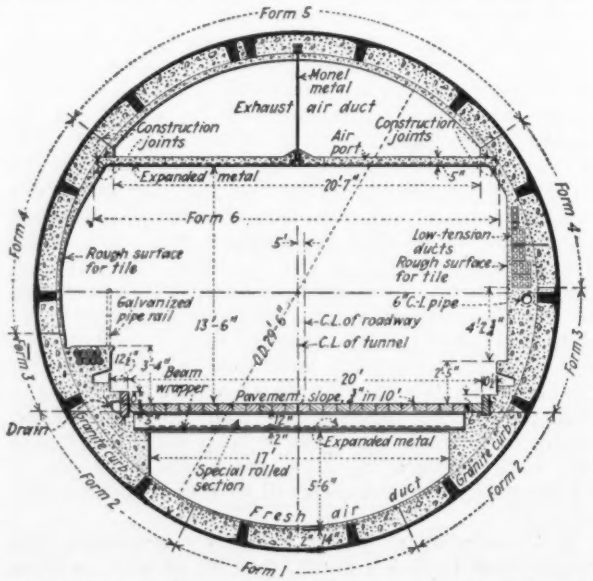


FIG. 2—CROSS-SECTION OF COMPLETED TUNNEL SHOWING EXTENT OF USE OF EACH CONCRETING FORM

The concrete was poured in seven stages using the six sets of forms indicated; two stages were poured with form 3 on the sidewalk side of the tunnel. Form 1 was wood while the others were of steel construction.

ing hopper was thus automatically provided. The old head-frames and cages in the shaft, formerly used for removing muck during the tunnel driving operations, provided an elevator for bringing cement to the charging platform and for other operations. There was also an open derrick-shaft for use when needed.

The arrangement of this concreting plant has proved very satisfactory since nothing but the actual mixing of the concrete is carried on in the shaft, all preliminary and incidental operations being done on the platform at the top and at approximately high water level. The mixers discharged directly into 1½-yd. side-dumping concrete cars operating on a track suspended from the top of the tunnel (Fig. 3). Three-car trains were hauled to the concreting point by electric locomotives.

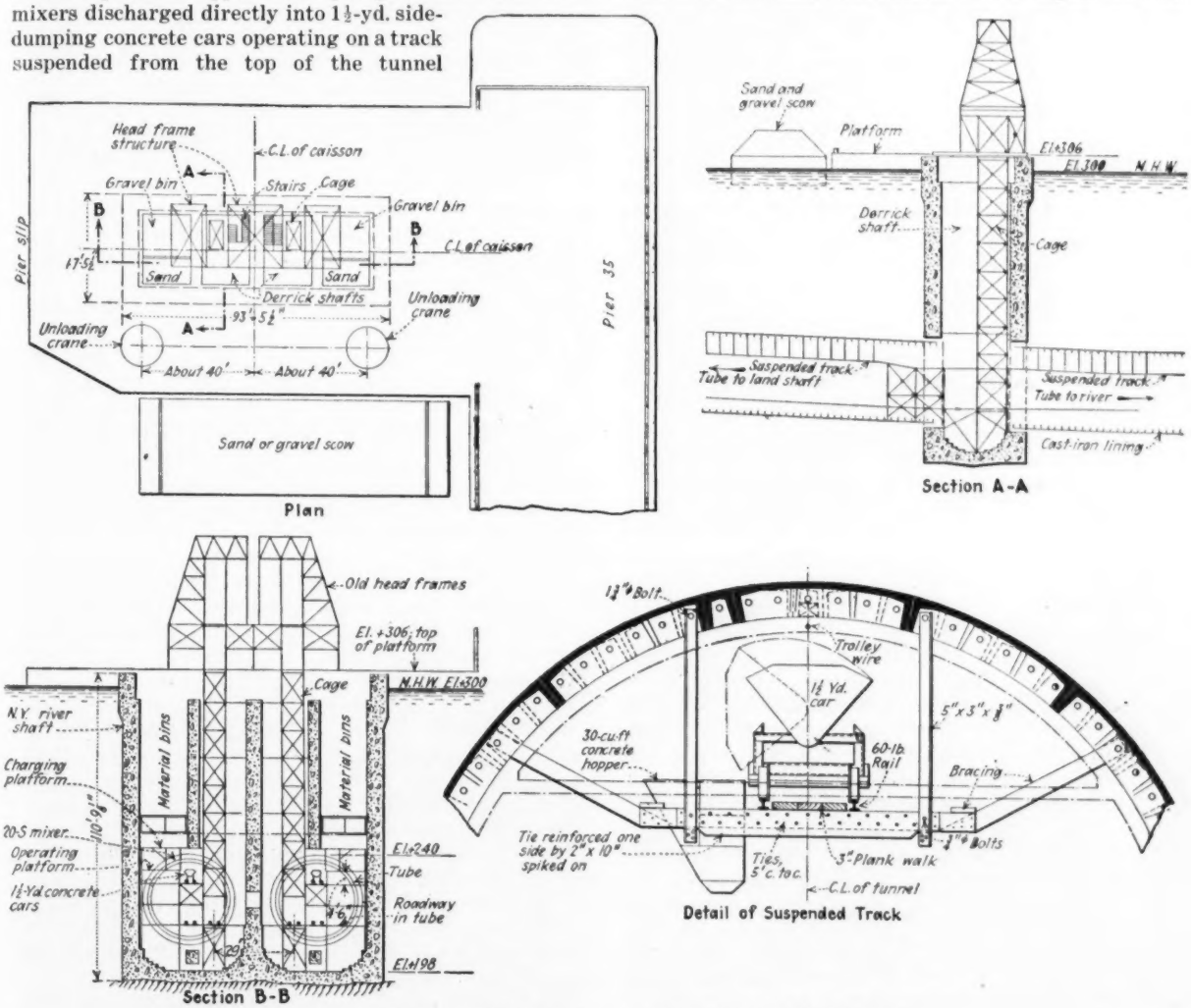


FIG. 2—CENTRAL MIXING PLANT IN NEW YORK RIVER SHAFT

Materials brought in at water level and fed to mixer by gravity. All concrete transported on hanging track except that for ceiling slab.

The use of the suspended track was one of the distinctive features of the work. The main factor governing the design of the concrete transportation system was the necessity for providing a sufficient elevation at the concreting point for gravity pouring of the major volume of the concrete. Considerable time and money were expended by the contractor in designing an incline for this purpose before he saw the possibilities of economy and efficiency that the suspended track would afford. Some concern was felt that the hanging weight might distort the tunnel and also that derailments might cause serious accidents but the system operated quite safely and satisfactorily. Besides providing the necessary height for gravity pouring, the suspended track system removed all concrete transportation from the tracks in the bottom of the tunnel leaving them free for other construction hauling.

As shown in Fig. 3, the track was suspended from two steel angles fastened to the steel lining of the tunnel by 1¾-in. bolts. Ties supporting the 3-ft.-gage track of 60-lb. rails, were bolted to the angles and the bents thus formed were braced against the sides of the tunnel as required. These supporting bents were hung from every other flange of the cast-iron lining, thus placing them at 5-ft. intervals. Sidings were provided where necessary to pass empties around incoming loads; details of construction were practically the same as for the single track except that 3 angles instead of 2 were used to suspend the track.

At the concreting point, several different methods were used for placing the concrete in the forms. In concreting forms 1 and 2, the concrete cars were dumped into a 30-cu.ft. hopper fastened between two adjacent ties (Fig. 3). From this hopper the concrete

was run into the forms through counterweight chutes whose maximum reach was 60 ft. in either direction from the hopper. Shoveling had to be resorted to in placing some of the walls and arches while a special elevator operating from the floor-slab level had to be used to place the ceiling slab since it was necessary to remove the suspended track just ahead of this operation.

Before any concreting was done, the cast-iron lining was thoroughly cleaned with air chipping hammers and brushes. Any seepage leaks were stopped by calking so that the ring would be absolutely dry. The invert was poured into form 1, of wood construction, through the counterweight chutes as previously mentioned. Upon removal of the forms, the concrete was given a sidewalk finish as subsequently was all the other concrete forming interior surfaces of the air ducts. In Fig. 4 are shown views of the special Blaw-Knox collapsible steel forms in the order of their use for the remaining concreting operations. These forms were all adjustable vertically by means of 16-in. screw-jacks while lateral adjustment and tightening were effected by smaller ratchet jacks. All forms were built in sections 15 ft. long. The invert was poured in alternate sections 15 ft. long.

Concrete Pouring by Stages—Form 2 was carried on a track laid on the completed invert and formed the lining up to the top of the floor slab level. Before concrete was poured steel beams of a special rolled H-section were placed on top of the form, transversely in the tunnel on 5-ft. centers. In order to provide a 2-in. wrapper on the bottom of these beams, two small precast concrete blocks, 2 in. deep, were inserted beneath each beam; this permitted the concrete to be spaded between the beam and the form floor. Expanded metal reinforcement was used in the slab between the beams. Concrete was poured flush with the top of the beams making a 14-in. floor slab; the granite block paving is placed on top of this. A 60-ft. section of steel form was poured each time and allowed to stand for 16 hours.

After the removal of form 2 the track on the invert was removed and replaced on top of the floor slab together with another track 13 ft. 3 in. c. to c. of rails to be used in carrying the travelers for the rest of the forms. Four sections of form 3, totaling 60 ft. in length, were used for the next two stages of pouring. Concrete was first carried up on both sides of the tunnel forming ledges for the duct banks to rest upon. A 6-in. cast-iron water main was embedded in this stage on the low tension side of the tunnel to be used for fire protection and flushing; valve niches were placed 120 ft. apart. On the high tension or sidewalk side of the tunnel the duct bank, of hollow tile blocks jointed with asphaltic cement, was next laid and concreted to the point shown in Fig. 3. This constituted concreting stage 4 and completed the work with form 3. Fig. 4-*B* shows how the concrete was dumped directly from the overhead track into the forms. In order to form a roughened surface on the concrete walls, necessary for bonding the glazed tile, heavy wires were welded longitudinally to the inner side of the wall forms. These included the part of form 3 used to concrete the low tension side of the tunnel, and all of form 4 which followed. The furrows thus made in the concrete by these wires may be plainly seen in some of the illustrations; they are spaced 3 in. apart.

After placing the 23 low tension ducts on the shelf formed by the third concreting operation, form 4 was erected and poured. In this stage of concreting and also on the low tension side concreted by form 3 occurred most of the built-in structures. All these openings had to be boxed out before the forms were erected. Near its top, form 4 was shaped to make a key-way in the concrete wall into which the ceiling slab was later fastened. The finished face of the concrete left after this, the fifth concreting operation, was normal to the tunnel lining at that point (Fig. 3) forming a shoulder against which the arch form, number 5, could abut. Most of the concrete in this stage was shoveled into the forms. A 60-ft. length of form was used and 16 hours allowed for setting.

The hanging track used for transporting the concrete ran across the traveler platform of form 4 and the concrete cars were dumped into bins on each side from where concrete was shoveled into the forms. The same procedure was used for the arch forms. Each 60-ft. section of arch form was composed of 6 steel plates running longitudinally on each side of the center line and a key plate section at the apex. Shoveling was resorted to in placing all concrete in these arch forms. However, as may be seen in Fig. 4-*D*, the flanges of the cast-iron lining formed several pockets between each ring, and while no trouble was experienced in filling these pockets in the lower part of the lining, it was found impossible to shovel them full in the arch.

After the removal of the forms concrete was grouted into each pocket, using 2 inserted pipes, one for concrete and the other for air venting. Two groutings were often necessary before the pockets were entirely full. This grouting work represented the only compressed air concreting used in the lining procedure. The arch was finally given a sidewalk finish. In this instance also, 60-ft. sections of forms were used but they were allowed to stand for 20 hours.

Concrete for the seventh concreting operation, the placing of the ceiling slab, had to be brought in on the track on the floor level since the hanging track was necessarily removed before the ceiling could be placed. The track which previously had been in the center of the roadway was now moved to one side leaving part of the roadway open for an elevator-traveler. This equipment (Fig. 4-*E*) was mounted on flat tired steel wheels which ran on the roadway slab. As the concrete cars were brought in, they were dumped sidewise directly into the elevator hopper. The concrete was then raised to form 6 where part of it was chuted and part was wheeled into place.

Monel metal hangers were fastened to the cast-iron lining in holes left in the key section of the arch. Two structural angles back to back running lengthwise in the tunnel were fastened to these hangers cutting the span of the ceiling slab to approximately 10 ft; high tensile steel tierods with turnbuckles were placed at 5-ft. centers across the tunnel in those sections resting in Hudson River silt; both of these were concreted into the ceiling slab. The castings for the exhaust air ports were also placed at this time. These with the expanded metal which completed the reinforcing system in the ceiling are shown in Fig. 5. The ceiling slab form provided for keying the concrete into the way shaped by form 4. Form 6 stood for 6 days.

Besides the expanded metal that was used in the

floor and ceiling slabs, two-way reinforcement of either ⅜- or ½-in. rods was placed in all concrete that was cantilevered out from the face of the walls. Since all the forms, except those for the ceiling slab, were held only from 16 to 20 hours, a very satisfactory continuity of operations resulted. Form 2, the first steel traveler form, was started out from the center of the tunnel and the others followed at the required intervals. The hanging track could transport cars of concrete to forms 3, 4 and 5 so that they could be poured simultaneously, and at the same time concrete brought in on the floor-level track could be placed in the ceiling slab. The 20-S mixers proved entirely adequate for these operations, the yardages for these forms being small.

Glazed Tile for Finished Lining—The original plans for the tunnel did not provide for a glazed tile lining over the concrete although the advisability of its use was considered. The late Clifford M. Holland, then chief engineer, subsequently made an inspection of tunnels in Europe several of which were tile lined. Upon his return, he so strongly advocated the use of tile in the vehicular tunnel because of the added improvement to lighting, appearance and sanitary conditions that it was finally adopted.

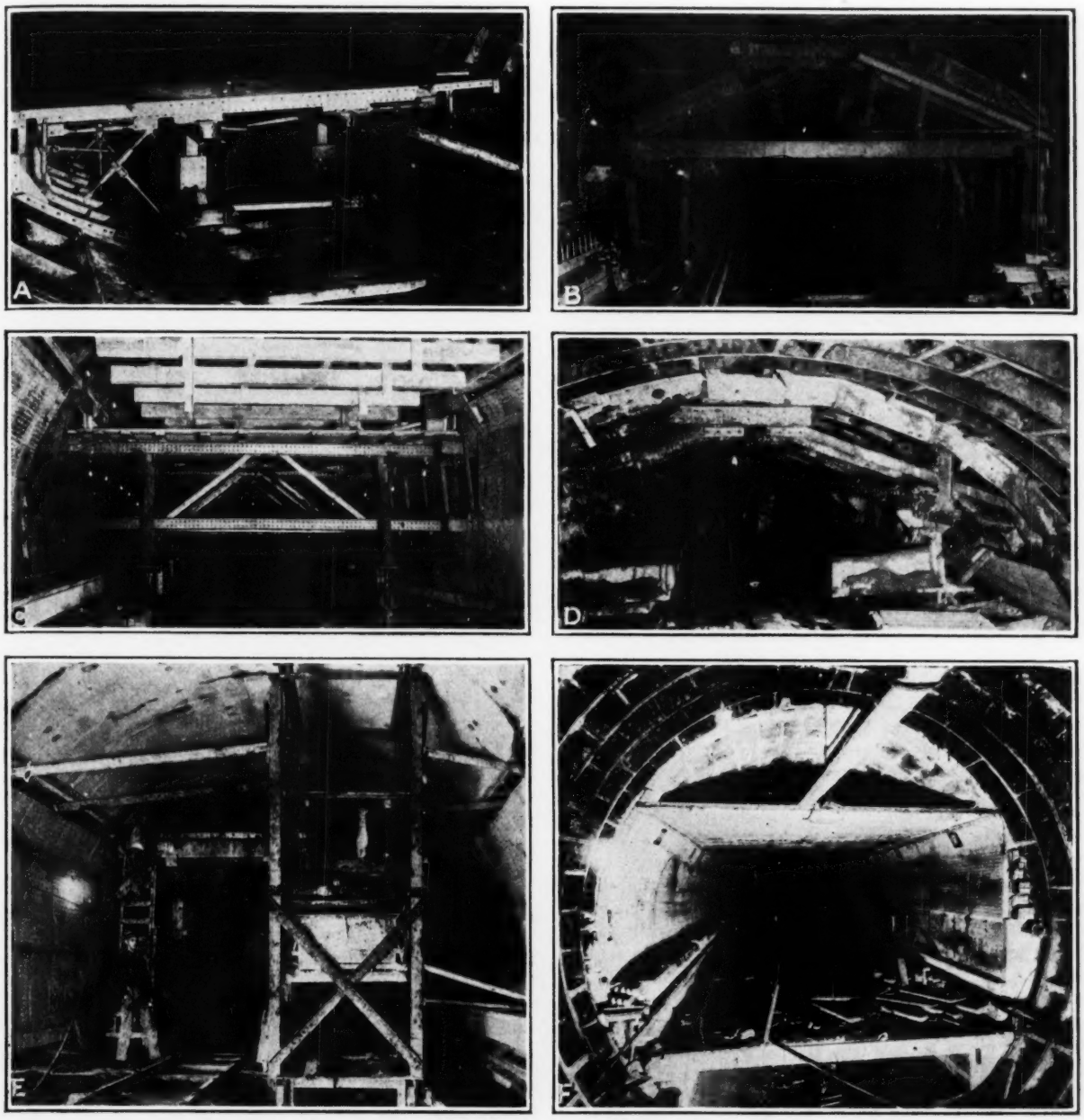


FIG. 4—FORMS USED IN CONCRETING THE HOLLAND VEHICULAR TUNNEL

Note—Compare with Fig. 2 for extent of use of each form

A—Form 2, the first steel form, in place. *B*—Form 3, concreting first stage above roadway; right-hand side is up to bench for low tension ducts; the bench on the left is ready for high tension ducts, which are next placed and concreting then carried up slightly above sidewalk level. *C*—Form 4, concreting remainder of side wall; note key-way for ceiling slab. *D*—Form 5, concreting the arch. *E*—Form 6, concreting the ceiling slab. *F*—Finished cross-section of concrete. Note light boxes in walls below ceiling slabs. All forms in this work, 2 to 6, were steel forms.

A tile lining in the tunnel must withstand constant moisture and outside temperature fluctuations. Since the tile that is used in New York's subways in many

FIG. 5—EXHAUST AIR DUCT AND CEILING SLAB REINFORCEMENT

instances has disintegrated under much less severe conditions than are contemplated in the vehicular tunnel, an exceptionally high-grade tile of known qualities was required. There being no authentic specifications for such a tile, the tunnel commission's engineers undertook an extensive series of tests to determine what qualities a wall tile would require in order to prove satisfactory under subaqueous tunnel conditions. The outgrowth of the tests was a set of specifications to which the tile purchased by the contractor must conform. The contract provided that the tile bought under these specifications must be guaranteed for 3 years against faulty material and workmanship. As finally let, the north tunnel will be lined with domestic tile; half of the tile for the south tunnel will come from Czecho-Slovakia and the other half from the Saar region of Germany.

Tile Setting Procedure—Tile is being placed on the tunnel walls as shown in Fig. 6. Parts of the shafts will also be lined. The total quantity of tile required is estimated at 365,000 sq.ft. which will cover 34,000 lineal feet of tunnel wall. The first operation in setting the tile is the application of a scratch coat of 1:2 mortar to the rough surface of the walls as made by the wires in the concreting forms. This scratch coat averages about ¼ in. thick, all variations in the concrete surface being taken up by this coat.

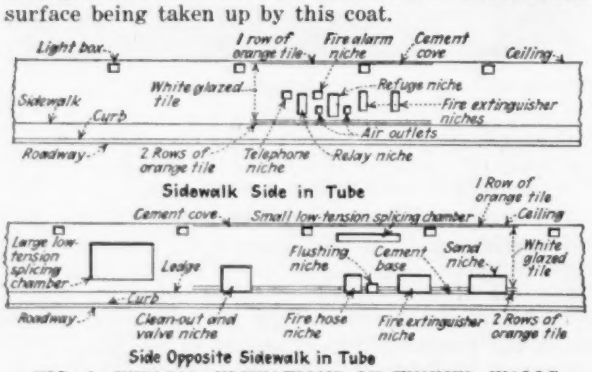


FIG. 6—TYPICAL ELEVATIONS OF TUNNEL WALLS SHOWING TILING AND NICHES

The floating method of placing the tile is used as distinguished from the method in which each tile is buttered with mortar. Temporary guide strips or screeds are mortared to the scratch coat, and the ⅜-in. mortar setting-bed of 1:2 mix with not to exceed 10 per cent lime is floated flush with these guide strips. A skim of neat cement is placed on the back of each tile to fill any depressions or irregularities. The tile is then beaten into place with the trowel handle bringing it flush with the other tile. Every fourth course of tile is brought to a true and straight line. Special trim tile for corners, coves, angles, etc., are used where necessary. The size of straight tile is 4¼ x 4¼ in., and not to exceed ⅜ in. thick.

Tiling work is now under way in the New York end of the north tunnel. All work is required to be carried on under lighting conditions similar to those that will prevail in the completed tunnel. The glazed surfaces of the white tile are required to have a light reflection of not less than 70 per cent. The white tile wall is trimmed with 2 rows of orange tile along the bottom and one row along the top. Over the top course of tile, the concrete wall is brought out even with the face of the tile with mortar and finished with a cove. A mortar base is also formed below the bottom row

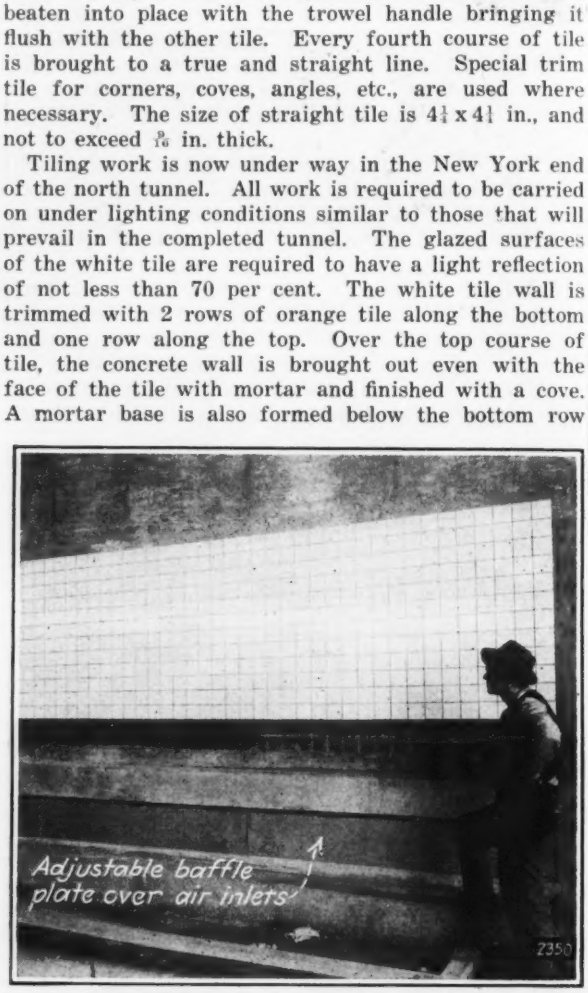


FIG. 7—GLAZED WALL TILE ON TUNNEL WALLS
Two bottom courses are of an orange color; one row of this colored tile is also placed at the top of the wall.

of tile. Markers made up of varied color tile designs are to be placed at ½-mile intervals along the tunnel and at the state line.

Bronze Metal Work—Because of the moisture to which the tunnel will be constantly subjected, practically all exposed metal work will be bronze. The sidewalk hand rail is made of galvanized iron since the expense of bronze construction in this instance was felt to be prohibitive. However, there are such a variety and number of built-in structures in the walls that require metal trim or doors that the total amount of bronze work will be considerable. Light boxes are placed at 20-ft. intervals along each side of the tunnel, fire alarm, fire extinguisher, telephone, sand, valve, flushing and cable splicing niches occur at varying intervals. In the ceiling are the slides and screens for

the exhaust air ports all of which require bronze metal work.

Along the sidewalk side of the tunnel are placed what are known as refuge niches. These are provided for traffic officers and inspectors. Wall openings covered with bronze gratings supply fresh air to these refuge niches while telephone and fire alarm boxes are placed on each side of them as shown in Fig. 6. As a final interior finish to the tunnel, the concrete ceiling will be painted white with a sufficient number of coats to provide for reflection.

Administration—The contractors for the concrete lining work in the tube section and the New Jersey approach steel bent section are Booth & Flinn, Ltd., New York City, with M. E. Chamberlain, chief engineer. Rodgers & Hagerty, Inc., New York City, have the contract for the New York approach steel bent section. L. Del Turco & Bros., Harrison, N. J., have the contract for furnishing and setting the glazed wall tile and for erecting the bronze work. The engineering direction of the joint New York and New Jersey Commissions is made up of Ole Singstad, chief engineer; Col. Frederic A. Snyder, engineer of construction; C. S. Gleim, assistant engineer of construction, and R. Smillie, engineer of design; M. S. Killmer, resident engineer.

Pennsylvania R.R. Car-Dumper for Loading Coal into Ships

Cradle Operated by Direct-Connected Engines Instead of By Gearing—Large Sheaves for Operating Cables

IN THE new car-dumping machine of the Pennsylvania R.R. at Sandusky, Ohio, for loading coal directly from cars into lake steamers, special features include unusually heavy construction, a combination of steam and electric power, and the use of direct-connected steam engines instead of geared machinery to operate the dumping cradle. This machine, shown by the accompanying view, is designed to handle 120-ton car loads. In its general operation (as in several other car dumpers), each coal car is pushed by a cable operated "barney" or truck up an incline to the cradle, where it is secured. The cradle and car are then hoisted in a steel tower and tilted so as to discharge the coal into the wide end of a triangular apron or box, from the apex of which a drop spout enters the ship's hatchways and delivers the coal into the hold. The height and inclination of the apron can be varied to suit requirements.

Reduction in maintenance expenses and prevention of breakdowns or interruptions to service were particular objects in the design. Four groups of 1¼-in. cables in seven parts provided for hoisting the cradle; ten 1¼-in. counterweight cables and eight ⅞-in. clamp cables also assist in the hoisting. Operating cables with a factor of safety 50 per cent higher than that generally used, and sheaves with a diameter of 48 times that of the cables (instead of 40 times or less), are introduced to give long life to the cables. Provision for 50 per cent impact while hoisting is said to be a departure from previous practice. An electric jib crane mounted permanently on the tower provides for handling machinery parts in repairs or renewals. On the barney or cable-operated truck which pushes the coal car up to the cradle, a spring buffer of 10-in. stroke is provided to reduce shock on the car and its draft rigging.

Direct-connected slow-speed engines with piston valves were adopted for the operation of the cradle, in order to reduce the vibration said to be experienced with high-speed geared engines. With an engine speed not exceeding 60 r.p.m., forty cars per hour can be handled. A similar type of engine operating the cable of the barney car is provided with an automatic slow-down and stop at each end of the car's travel. In the tower, the posts are so spaced as to avoid the necessity of spotting the cars to an exact position; this also tends toward more rapid operation. Electric motors operate the screw-drive mechanism and the hoisting

NEW COAL-CAR DUMPER AT SANDUSKY, OHIO

mechanism of the apron or pan. An operating room on the tower is so placed as to give a good view, while a small cab carried by an extension of the apron is provided for a man who controls the position of the discharge spout in the hold.

This car dumper was designed and built by Heyl & Patterson, Inc., Pittsburgh, Pa. The contract was let Nov. 24, 1924, and the machine was put in operation on June 26, 1925. All work was under the direction of Robert Trimble, assistant chief engineer of the Pennsylvania Railroad System.

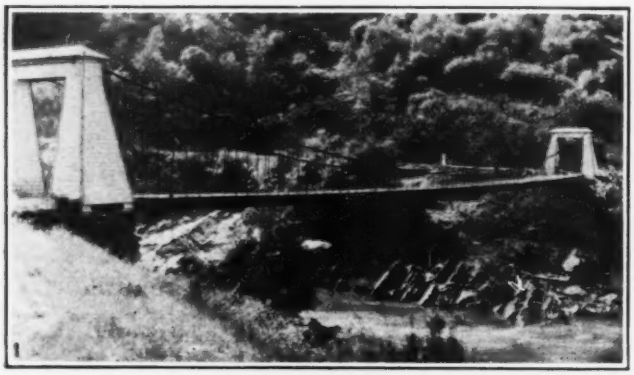
Hydraulic Regulating Gages

A paper on the subject of field engineering and erection problems in connection with various types of hydraulic regulating gages which was read before the Montreal branch of the Engineering Institute of Canada Oct. 8, 1925, is published in the November issue of *The Engineering Journal* of the Engineering Institute of Canada, 176 Mansfield St., Montreal.

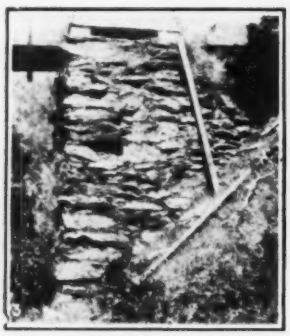
California Suspension Bridge in Service Since 1862

Cables Previously Used in Another Bridge and Dragged Down River to Present Site Still in Good Condition

SPANNING the American River in California, on the road from Auburn to Coloma, where gold first was discovered in 1849, is a suspension bridge built in 1862 that is still in service. No plans of this structure are on file in the office of the Placer County surveyor, and it is suggested that there may have been none when the bridge was built. Only such details as could be obtained by inspection are therefore available. The span is 258 ft., and there is no stiffening system. The usual county highway traffic uses the bridge without any restriction other than a notice limiting speed to 4 m.p.h. and the total loads to 6 tons for trucks and 8 tons (including animals) for wagons.



FIGS. 1 AND 2—CALIFORNIA SUSPENSION BRIDGE STILL IN USE AFTER 63 YEARS' SERVICE



FIGS. 3 TO 5—ABUTMENT AND ANCHORAGE OF OLD SUSPENSION BRIDGE OVER AMERICAN RIVER

The bridge is suspended from cables 11¾ in. in circumference built up of wires which now measure No. 7 gage but which are believed to have been No. 6 gage at the time of construction, there having been doubtless some loss in size due to weathering. The wires, coated with tar or asphalt and generally in good condition, are bound together by wire wrapped spirally, the number not ascertainable. The cables are supported on pyramidal wooden towers built of four 18x18-in. pine timbers.

The cable anchorages consist of heavy clevises containing a flat shackle pin around which the ends of the individual wires are looped. The clevises are anchored into the rock in some unknown manner—probably leaded in, as was the custom among miners in those days. The ends of the wire are looped back to the main cable.

The hangers, spaced 3 ft. on centers, are ¾ in. in circumference and are composed of ten wires looped over cables and under floorbeams and wrapped spirally.

At the center of the span the floor system has a sag of about 22 in. below the horizontal. At this point the main cables are 53 in. above the floorbeams. There is a uniform spacing of 13½ ft. between the main cables while between wheel guards the width is 12 ft. 8 in. The ends of the span rest on masonry piers.

The flooring consists of 4x6-in. timbers laid diagonally on nine 4x6-in. stringers, placed flat, which in turn are supported by 4x12-in. floorbeams spaced 3 ft. Two longitudinal tracks, each made of two 3x12-in. planks, have been laid on top of the flooring. Two 2x12-in. planks placed on edge on the floorbeams just inside the hangers and bolted together form the wheel guards, and inside of these still further protection is provided by a 3x4-in. plank bolted to the flooring.

The site of the bridge is 2,000 ft. above sea level, in the foothills of the Sierra Nevada, a region free from salt fogs.

The history of the bridge as gathered from local residents recalls the stirring days of '49, for it was at Murderer's Bar that these cables first were used in a bridge erected over this same river. In 1862 that bridge was dismantled and the cables were dragged down the river and used in the present bridge, constructed by Placer and El Dorado counties as a toll bridge. In 1911 the wooden parts were renewed and towers housed.

The foregoing data are due to Harlan D. Miller, bridge engineer of the California Highway Commission, and his assistant, L. D. Packard, who made an inspection and report on the structure (which is not on the state highway system) at the request of *Engineering News-Record*.

Engineering in the Small City

A series of notes from the field on the Problems and Practices of the Municipal Engineer in the Cities Below 100,000

The Editor Visits the City Engineer

Snapshots of Our Representative Small Cities

Charleston, S. C.

CITY HALL PARK, CHARLESTON, S.C.

LARGEST CITY IN SOUTH CAROLINA and county seat of Charleston County. Seven miles from the ocean, on a peninsula formed by Ashley and Cooper Rivers, which unite in a broad bay affording an excellent harbor. Charleston is a city of historic and scenic interest. A church dates back to 1761, there is a subscription library dating from 1747. The city has been an important cotton port for a century; the harbor admits large vessels to the docks, there are nine miles of waterfront. The main exports are cotton and lumber products; besides manufacturing these, fertilizer is produced in the city, and there are other factories. The history of the city began with settlement in 1670 by the English. Its connection with the Revolutionary War and the Civil War beginning with the attack on Fort Sumter is well known. Charleston was incorporated in 1783. Pop. 1920, 68,000.

CHARLESTON is older than the American Revolution. Roaming about through the city one is struck with the fact that this is one of America's first settlements. Tablets are scattered throughout the older section of the city indicating the historic significance of this and that structure. Here is a fine old house with spacious porch which was British headquarters during the Revolutionary War as well as federal headquarters during the Civil War. One feels the atmosphere of history. Even the pretentious houses that face Fort Sumter, houses that bespeak a grandeur of architectural style in which all of the Grecian orders boldly combine with the colonial style, seem to cling to a tradition that is the old South. Therefore one might easily suspect engineering facilities in the city to have lagged behind a modern commercial trend. Yet there is found in the city a very businesslike city engineering organization, fully alive to the necessity of providing technical facilities for a growing population. Though the principals in that engineering organization are old in the city's service, the city engineer, J. H. Dingle, having been brought up in the department, there is nothing antiquated about the manner in which they attack the city's engineering problems.

Charleston is a city governed by a mayor and council, who appoint the numerous committees to which detail is directly delegated. All of the engineering, save that having to do with water supply and port utilities, is in charge of the Board of Public Service, composed of the mayor ex-officio, the chairman of the ways and means committee of city council ex-officio and three citizens not members of city council, appointed by the mayor with the approval of the city council. The city council appoints the city engineer, who is the executive head of the board of public service. Mr. Dingle has been city engineer most of the time since his graduation from Cornell thirty years ago. Until about two years ago municipal activities were split up among a number of committees of city council, for whom the engineering work was provided by the city engineer's department; recently, however, all of this work was consolidated under a department of public service with the city engineer as executive head in charge of design, construction and maintenance of all engineering work except water supply and port utilities. When the water supply and the waterfront were purchased by the city from the corporations previously operating them, bonds were issued under authority granted by the state legislature for these specific purposes; and to handle these activities commissions were designated—the commissioner of public works in the case of water supply and the port utilities commission in the case of waterfront.

Earthwork Conditions—Being a seaport city and flat in topography, Charleston has one big problem, and that is concerned with its sewers. While the elevation of the city varies from 8.5 ft. to 20 ft. above mean low water, an appreciable portion is at lower level and there is a tidal variation of more than 5 ft. In times of severe storms that variation may be as high as 12 ft. Adequate sewerage service then becomes a real problem. What became the first sanitary sewer was a 3x5-ft. box section brick drain with a cypress floor. It was built about 1850 and was installed for fire protection as well as for drainage purposes. It consisted of two lines of drain in the direction of the longer axis of the city and two crosstown lines with a total of four outfalls, controlled by gates, one into the Cooper River and three into the Ashley River, at whose confluence the city lies. The floor was level throughout about 1.5 ft. above mean low water and it was contemplated that the drains could be flushed by closing all gates at high tide thereby retaining 3.5 ft. of water until low tide, when by opening one or more of the gates, the flow of water would flush a section or sections of the drain. In operation this was not eminently successful. At high tide preceding nightfall all gates were closed and sea water retained in the drains for fire purposes until low tide succeeding daylight.

Sewage Service—As the city grew in size there was need of sanitary provisions and house connections for sewage were led into the drains. These drains with the connecting pipe drains developed into a "combined" sewerage system, inadequate, insanitary, inefficient; and the construction of a real separate sanitary sewerage system was commenced in 1893. Additions have been made from time to time. Automatic ejectors were first installed to force sewage from the mains to the rivers, but the last of these was discarded last year when construction of the sanitary system was practically completed with the addition of 20 miles of new sewers. Nine pumping stations have been installed, though one is temporarily out of commission, and sewage is pumped automatically into the two rivers through a series of outfalls.

Due to the location of motors of the horizonal type pumps at the bottom of deep pits, any leakage from the pumps accumulating in the pit is liable to flood the motor and when this occurs, although seldom and at

night between visits of the pump tender, the pump is temporarily put out of commission. The vertical type, planned for early use, with motor fifteen or more feet above pit bottom will not be subject to this danger.

The actual provision of sanitary facilities, however, is the smallest part of the city's sewer problem. In the first place with such flat topography, low gradients are necessary. Then the character of the soil is such that construction is extremely tedious and expensive and reconstruction often necessary in certain limited sections. The city is set off into drainage areas, and each area is drained of its sanitary sewage by a pump, which accounts for the number of pumping stations. Rarely, on trunk lines, is a better grade than 0.25 per cent attained, and often a grade as flat at 0.10 per cent is used. On the smallest sewer sections a grade of 0.30 per cent is never exceeded.

Practically the entire city is underlaid with mud or clay. In some portions of the city there is a marl, but even that is often filled with pockets, which makes it unreliable. The city contains an area of 5.85 sq. miles, and 1.36 of that is mud flats. Part of the other area formerly was mud flat but has been filled, and it is in those filled sections (which are small) where the greatest difficulty is encountered in subsurface installations. The clay varies from stiff to almost a jelly. Any pipe of size must be carried either on a timber foundation laid directly in the trench or on piling. Practice has therefore become fairly well standardized in the respect of sewer installations. If the soil will stand it, pipe is laid directly on the ground, but such installations are exceptional. Where the soil is soft either 2x12s or 3x12s are laid as mud-sills in the trench on 5 ft. 4-in. centers. Two 4x8-in. pieces (with the 4-in. dimension vertical) are then laid on these sills throughout the length of trench, with a 4-in. space between them. The pipe is laid on these longitudinals and then wedged clear of them by 2x4x8-in. or 2x6x12-in. wedges, depending upon the size of the pipe. The wedges are so placed that the bells are clear of the longitudinals.

If the soil is too springy and piling is needed, timber piles (two-pile bents) are driven on 5-ft. centers. The spacing between the piles in each bent is 3½ ft. for drains of 3 and 3½ ft. in width, and 4½ ft. for 4 and 4½ ft. widths. Stringers of 6x6-in. timbers are used as longitudinal caps. A floor of 2x12s is then laid flush and the drain rests upon this. As it happens the former practice is most used for the large-diameter sanitary pipe and the piling for the box-section storm drains. At times the latter are laid on a plank foundation in the trench without piling.

The old drains, originally installed for drainage and fire protection, are partially in service now as storm drains. As they had to be cleaned at least every other year, and as they have carried pretty rough material during more than a half century, the cypress floor has worn out in some places. There is very little rotting, excavations for replacement showing the wood to be in excellent condition. However, where the wood floor has worn, the drain has disintegrated, as the brick wall rested only upon the wood. But perhaps three-fifths of the old drains are now in use. The storm drainage system has been enlarged considerably recently. New drains are of box-section and built of reinforced concrete. They are on the average 3x5-ft. inside section. The mix used is 1:2:3½ and the reinforcing is placed at least 2 in. from the surface.

Engineering Work

Timber sheetpiling has to be used on practically all trench work. In some sections it is even then difficult to trench. There is one case on record wherein the hydrostatic pressure was so great and the ground so mushy that sheetpiling, after being driven, was floated out.

Paving—The character of the soil affects greatly the paving work now being done. In those sections of the city where the subgrade is particularly mushy, it has been found impracticable to put a cement-concrete base down under an asphalt surface. It is found altogether too rigid for made ground. In natural soil, however, a 5-in. cement-concrete base is used. In filled land experimentation is now being carried out on a street made of sheet asphalt laid on a cinder base. The cinders are not crushed and contain considerable clinker. It is laid on the subgrade 6 in. thick and rolled thoroughly, after which the 4½-in. rich asphalt binder course is put down in two layers, each being carefully rolled, and upon that a 1½-in. wearing course. The 6-in. cinder mat forms the base for the black top. The effect of this is to allow general subsidence of the base without consequent cracking of the pavement. Some cement-concrete base laid on filled ground has been badly broken up, the failure usually occurring along the center line of the street. It is believed that oyster shells would be even superior to the cinders but they are not available in large enough quantities.

Paving in Charleston dates from the earthquake that almost destroyed the town in 1885. After the earthquake, funds for relief and reconstruction came from all parts of the world. The gifts were generous, and when all needed relief had been cared for there was still money left. The mayor of that time secured additional funds and more than 20 miles of Belgian block pavements were laid. Those pavements lasted the city for many years. In fact most of the Belgian block has been taken up only during the past five years. The city now has less than two miles of that type whereas in 1919 it had 16 miles of it and originally a mileage of between 25 and 30.

In 1912 a paving law was passed whereby abutting property on each side of a street paid one-fourth the cost of roadway and one-half the cost of its sidewalk. The city paid the balance, amounting to 50 per cent of road and sidewalks in front of abutting property and all curb, intersections and drain construction. Since the city, under this ordinance, had to pay more than 50 per cent of the cost of roadway and sidewalk and all of the cost of drain construction, the amount of work was limited by the amount of money which the city council could raise by general taxation. To remove this limit to improvements and decrease general taxation the law was changed in 1920 and now abutting property pays for all curb, roadway and sidewalks, including intersections and for drainage equivalent to the cost of a 12-in. terra-cotta pipe with appurtenances. Previous to 1912 the cost of the paving had been carried entirely by the city, with the result that little was laid from year to year. Now, however, the monthly payroll for paving averages about $60,000, and has averaged that for almost two years. The city, during that period, has laid sheet asphalt almost exclusively.

Of the Small City

Paving certificates are sold, usually at a premium, on the New York market, and in sums ranging from $200,000 to $500,000. They yield six per cent and the abuttor must pay seven per cent on deferred payments. The payment, by the property owner, of the cost of street intersection paving, is one of the minor problems which confront the department. There is such a variation in the cost, due to the width of the intersecting streets and the lengths of the blocks from the intersections, that the office engineer is constantly leaving his desk to explain to some one just how the cost is figured. The property for one-half the length of the block from the intersection on each of the four adjoining blocks pays for the intersection on a front-foot basis. If the intersecting streets are 36 and 40 ft., respectively, and the blocks 200 and 400 ft. long, there are four cost variants at once to be considered.

One of the features in the paving program now going forward lies in the fact that where Belgian block was being replaced, bids were taken on asphalt on a 5-in. concrete base. The granite block was taken up and crushed in the city's crusher. The rock thus secured was sold to the contractor and what he used in the reconstruction was credited to the general fund.

Abutting property must pay for paving work inside of 10 years and for sidewalks, which are all cement concrete of a 3-in. base with a 1-in. wearing surface, in three years. When streets are put on the paving list the fact is advertised for a stated time and if the majority of the property owners object to the paving it may be taken off the list. Cost of paving, sidewalks and curbs runs from $5 to $8 a front foot, depending upon the subsurface conditions, street widths, etc.

In advance of paving all existing underground construction is placed in good condition and new construction provided where necessary. Old drains are repaired or replaced with new drains and sewers are placed in good condition. Gas and water mains and services are examined and repairs or replacements provided by the water department and the gas company without expense to the property holder. Where new drains are laid the abutting property is charged, according to frontage, for the cost of a 12-in. pipe and appurtenances.

If the new drain is of greater diameter than 12 in. the city pays the difference in cost between the 12-in. and the size laid. House connections, 6 in. in diameter from sewers and drains to curb line, are laid at approximately 30-ft. intervals by the city in advance of paving and sealed up at curb line. Before a property holder is allowed to connect with the sewer or drain he must pay the city $15 or $20, depending on the width of the roadway, for each connection. This charge covers the cost of labor and material for the connection. From the curb line the connections are extended into the property by the property holders.

Foundation work in the city is at times difficult. Because of the mushy character of the soil in certain sections buildings of size must be carried on piles, either reinforced-concrete or timber. Some piling has been driven 100 ft. before adequate bearing was found. The city has had difficulty in filled areas when building operations are being carried on near sewer pipe. The vibration from driving piles for such buildings has at times broken the sewer connections and made reconstruction several times necessary. Partly due to this recurrent reconstruction cement-filled pipe joints are considered too rigid. The latest material to be used is an elastic asphalt joint. Two sections of pipe are usually jointed on the top of the ground and these lowered and jointed to previously laid sections.

Water and Other Services—The water supply comes from Goose Creek, about 17 miles from the city, where an impounding dam has created a supply of approximately 3 billion gallons. The average daily consumption is around 7 m.g. The water board is composed of three members elected by the people, the mayor and at least one other member of the council. The elected commissioners, however, control the water board, which functions entirely outside the city organization. It has its own engineers. The only control the city has lies in its ability to have a voice in what shall be done with surplus funds. The board even collects its own bills. The water supply is filtered.

Garbage is dumped at two dumps, one near the bank of each river at opposite sides of the city. Several years ago the city purchased a destructor with a capacity of 40 tons every 24 hours. The plant was never run continuously, but when it was first installed it was operated at the rate of 20 tons every 10 hours, a maximum rate. However, the destructor fell a victim to politics and has been in disuse for some time, principally because incompetent or inadequate superintendence allowed the destructor to fall into bad condition, the fan for forced draft having burned out among other things. For some time it has lain idle. The dumping of garbage within the city limits is becoming such a nuisance that steps must soon be taken to provide adequate disposal. A council committee is now studying incineration in other cities with that in view.

An interesting detail of the city engineer's work, which his assistant has been recently doing, is the retracing of old land lines around mud-flat property which the city is thinking of buying to fill and sell as residential property. When an exact survey was looked for none was found. So the assistant city engineer got all of the plats of the area he could find, one of which was the original grant dated in 1742. Each plat showed the location of a boundary stream, with courses, but no distances. These plats, which bore the dates, besides the original, of 1793, 1842, 1852, 1855, 1857 and 1877, were matched as nearly as possible, a starting point agreed upon and the boundaries determined. For this it was necessary to adjust bearings (which were magnetic) to a common year. It is believed that the present survey is the only accurate one ever made of the property. Most of the plats were probably made from drawings sketched on the site after a magnetic bearing or two had been read.

Two small details of engineering administration which are unusual are the installation of street names in the sidewalks at each corner of every street intersection, and the use of advertising around trash cans. The street names are cast in bronze plates and countersunk in the sidewalk. They greatly facilitate finding one's way about the city. Advertising around trash cans is carried on the four sides of a box which fits about the circular can. Illumination is given the signs at night. The city collects a small revenue from the sale of the advertising, let to an agency.

Principles of Soil Mechanics: V—Physical Differences Between Sand and Clay

Commonly Noted Differences in Behavior—Grain Size and a New Uniformity Diagram—Shape of Grains and Structure—How Shrinkage, Cohesion, Plasticity and Settlement Are Affected

By Dr. Charles Terzaghi

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ON SUPERFICIAL examination sand and clay seem to be essentially different materials. Their salient differences are summed up as follows:

Differences Between Sand and Clay

Clay	*Sand*
(1) Volume of voids may be as high as 98 per cent of the total volume.	(1) Volume of voids is about 50 per cent at the maximum.
(2) Shrinks in drying.	(2) Does not shrink in drying.
(3) Has a very marked cohesion, depending on the moisture content.	(3) Has negligible cohesion when clean.
(4) Is plastic.	(4) Is not plastic.
(5) Compresses very slowly when load is applied to the surface.	(5) Compresses almost immediately when load is applied to the surface.
(6) Is very compressible.	(6) Is far less compressible than clay.

Each of these properties represents the combined effect of several causes. Therefore, though the statements of the list are typical of what is found in current literature on soil mechanics, from a physical point of view they are no more satisfactory than, for example, the statement that two kinds of rock differ in brittleness, or two kinds of paraffin in tenacity and consistency. None but crude empirical conclusions can be drawn from such vague and general allegations, at the risk of confusing properties which physically may be altogether different. Atterberg, for example, confused the compressive strength of semi-solid clay with its resistance to penetration, and after assembling such heterogeneous data in a single diagram he was led to erroneous conclusions (see his "Konsistenz und Bindigkeit der Böden," *Internat. Mitteilungen für Bodenkunde*, 1912).

To characterize the properties of soils accurately we are obliged to trace these properties back to their physical sources. For the properties of clay this has been done in the preceding articles. It remains to analyze the properties of sand in similar manner and compare them with those of clay.

Grain Size and Uniformity—Considered as grain aggregates, clay and sand are characterized by their size of grain and uniformity. These factors are best expressed by a graphical representation of the results of mechanical analyses. The type of graph used should be such that the uniformity curves for materials of similar degree of uniformity will be of similar shape even though their fineness differs—the shape of the curve representing any material should be independent of the "effective size" of the grains. This can be accomplished by making the abscissas of the diagram proportionate to the logarithm of grain diameter. Thus, in Fig. 1, $x = a \log d$. Accordingly, a grain diameter d_2 which is n times as large as a grain diameter d_1 will be represented by a point at a fixed distance ($a \log n$) to the right of the point d_1, regardless of the absolute values of d_1 and d_2. Such a diagram presents exceedingly instructive uniformity curves.

Uniformity Curves—Fig. 2 represents the mechanical analyses of nine different materials. Abscissas represent logarithms of grain diameter, and ordinates represent the total weight of the grains of diameter smaller than this value, in per cent of the weight of the total mass. Points corresponding to Hazen's *effective size* are located on a horizontal line having the ordinate 10 per cent. All curves representing materials with an equal *uniformity coefficient* (Hazen) have an equal

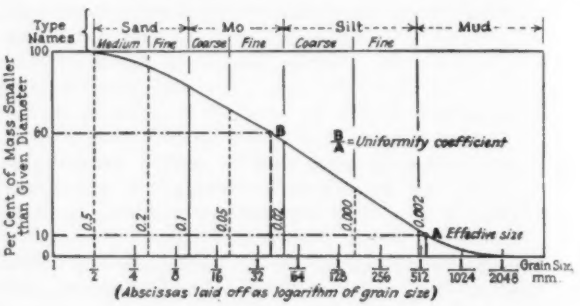


FIG. 1—METHOD OF REPRESENTING UNIFORMITY OF SOILS
(Form of curve is independent of fineness and depends only on uniformity.)

difference between the abscissas of their 10 per cent and 60 per cent points (see Fig. 1), regardless of whether the material is a coarse gravel or a colloidal powder.

The more uniform a material, the steeper is its uniformity curve. Hence two materials of different fineness but identical uniformity are represented in the diagram by curves of identical shape, and the fineness of the material (effective size) merely determines their position along the length of the diagram. Due to this property of the uniformity curves Fig. 2 reveals at a glance that in general *clays are far less uniform than are sands.* The loess from Virginia City represents an intermediate type in both uniformity and effective size.

The terms "mo," "silt" and "mud" used in the diagrams were originally proposed by Atterberg, and they seem to serve their purpose better than any other.

Shape of Grains — The grains of sand may be rounded or angular, with smooth or rough surfaces. Though these properties have a marked influence on internal friction, elasticity and permeability, yet all sands are alike (and differ from clay) in that their grains are bulky and rather rigid. Scalelike particles, as mica scales, represent only a minor accessory constituent. In contrast, clays are chiefly composed of flexible, scale-like particles. To be sure, the constituents of a "micro-mud" are so small that their shape can not be discerned even under a high-power microscope. Yet the assumption that clay particles are scale-like is sup-

ported by many proofs, of which a few may be mentioned.

A previous article described an apparatus called the interference contact indicator, consisting essentially of two glass strips enclosing a thin film of *residual* water. The film thickness, estimated by the Newtonian colors surrounding the water spots, amounts to about 0.1μ. In making several such contact couples I used (instead of distilled water) a very dilute suspension of mud, with particles of about 2μ size, and the water spots accordingly contained numerous clay particles of diameters 1 to 2μ. As the thickness of the films was not unless its particles are smaller than about 0.1μ. However, clay particles of equivalent diameter as much as 2μ have, on account of their scale-like shape, as small a volume as the volume of bulky particles of diameter approximately 0.1μ. For this reason a clay whose largest grains have an equivalent diameter of 2μ, or 0.002 mm., possesses all the properties of a colloidal substance, and Atterberg was fully justified in calling all the clay particles below 2μ colloidal mud.

It is interesting also to recall that in examining colloidal powders produced by crushing and grinding various minerals, Atterberg found that only minerals

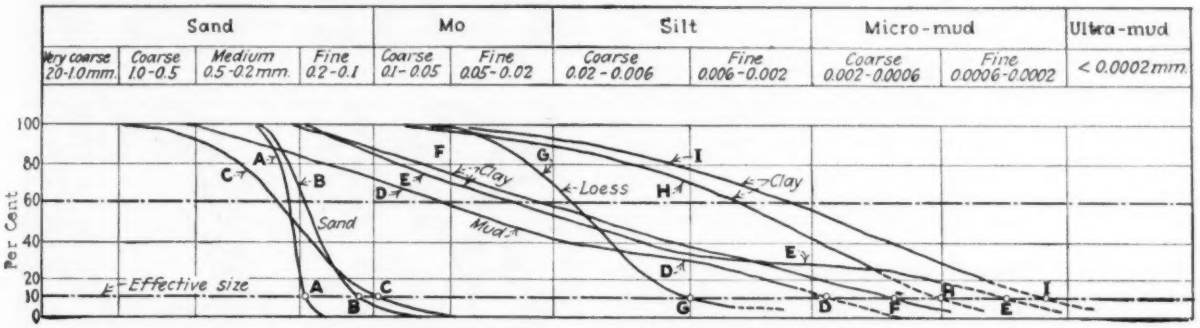


FIG. 2—NINE TYPICAL SOIL UNIFORMITY CURVES

A—Coastal dune sand, Beklemé, Thrace.
B—Beach sand, Rumeli Kawak, Thrace.
C—Glacial sand, lower end of Ankogel Glacier, Austria.
D—Mud, upper part of Golden Horn.
E—Yellow residual clay, east shore of Bosporus.
F—Yellow marine clay, from earth slide in Thrace.
G—Loess, Virginia City, Ill.
H—Blue marine clay, from earth slide on Black Sea Coast, Thrace.
I—Yellow marine clay, washed out of clay (*F*).

more than 0.1μ, the clay particles could not possibly be other than scale-like.

This direct evidence is strongly confirmed by indirect evidence drawn from permeability tests. The semi-empirical formula for the coefficient of permeability of clays (previously given) leads to the expression for the reduced coefficient of permeability, $k_r = 1.9\ d^2$ (cm./sec.), while the formula applicable to sand is $k_r = (174 \text{ to } 100)\ d^2$, in both of which d_w is the effective size. It thus appears that the coefficient of permeability of sand is 50 to 80 times greater than that of clay for the same effective size of grain. Both formulas refer to percolation at a standard temperature of 10 deg. C. through a material with a standard volume of voids of 50 per cent. In deriving the formula for clay it was further assumed that the water percolating through the clay has normal viscosity in spite of the small size of the voids. Hence the enormous difference between the formulas cannot be due to anything but a difference in the shape of the particles of the materials.

It is to be remembered that the term "diameter of a clay particle" by no means indicates the diameter of a globular grain of equal volume, but rather the diameter of a globular grain which sinks through the water at the same speed as the clay particle ("equivalent diameter"). As scale-like particles always sink with the flat side approximately horizontal, the volume of such a particle amounts to only a small fraction of the volume of a sphere of the same equivalent diameter. Therefore, even though sand be reduced to such fineness as to have the same equivalent grain diameter as a clay, yet a given volume of the sand would contain only a small fraction of the number of particles in an equal volume of clay, a fact which fully explains the difference between the two permeability formulas.

In chemistry a powder is not regarded as colloidal of laminated or scaly structure furnish plastic mud; and all clays are plastic.

Sketch *D* in Fig. 3 shows a microscopic picture of the grains of coarse silt (0.02 to 0.006 mm.) extracted from a blue marine clay. A dilute suspension of this silt, examined under the microscope, was found to contain no colloidal particles at all. When the cover glass was shifted back and forth, numerous colloidal particles

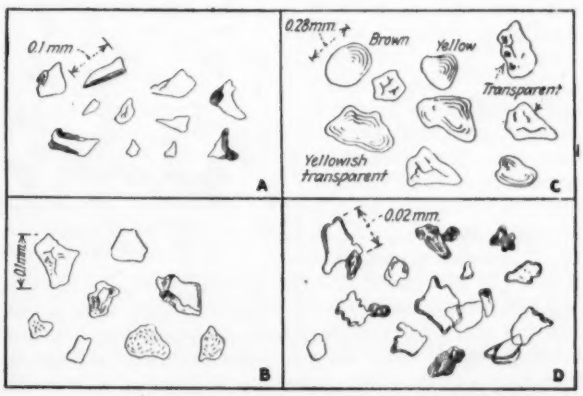


FIG. 3—CHARACTERISTIC SOIL PARTICLES (ENLARGED)

A—Crushed quartz. *C*—Dune sand (*A*, Fig. 2).
B—Glacial sand (*C*, Fig. 2). *D*—Coarse silt (from *F*, Fig. 2).

with a distinct Brownian movement appeared, showing how fragile are the scale-like particles. This fragility undoubtedly represents one reason why the uniformity curves of clays are so characteristically different from those of sands.

In conclusion it may be stated that throughout the author's studies no essential difference was found to exist between sands and clays other than the difference in grain size and shape. It will be shown, however,

that these two differences are fully adequate to explain the more obvious distinguishing features of the two materials.

Loose and Dense Structure of Aggregate—When a grain aggregate (sand or clay) in suspension is allowed to settle, sedimentation proceeds gradually, because the particles floating next to the bottom of the basin reach the bottom first. Suppose, now, that part of the sediment has been deposited, and a newly-arriving particle settles on its uneven surface, Fig. 4. Its movement, hitherto vertical, is disturbed by two new forces, the resistance of the sediment to penetration, and initial friction* acting at the point of contact between particle and sediment. If the grain has the size of a sand grain, the initial friction is negligible compared with the weight of the grain. The weight and the reaction, then, form a couple which rolls the particle down to the bottom of the adjacent depression. The structure of the sediment thus formed will be loose (Fig. 5, upper right). By jarring the vessel the structure may be made dense (upper left). As there is practically no adhesion between the particles, the maximum volume of voids cannot be much larger than the corresponding volume of voids of a mass of equal spheres, i.e. 47.6 per cent, and in fact measurements show that the volume of voids of a cohesionless sand never exceeds about 50 per cent (void-ratio 1.0). On the other hand, if the arriving particles are very small the bond produced by initial friction may be stronger than the rolling tendency, so that the particles remain in the position of first contact, and the structure of the sediment becomes spongy (lower left in Fig. 5), with a maximum void-ratio (as found by measurements) of about 4.

Let us finally assume the particles to be of colloidal size. Such particles remain in suspension forever unless they are precipitated by adding a few drops of an electrolyte. Before the electrolyte was added the particles moved with a considerable speed through the liquid (Brownian movements) and repelled each other because of their electric charges. The electrolyte neutralizes the electric charges without eliminating the physical cause of the Brownian movements. Hence the particles collide in the liquid, and as soon as two particles collide initial friction comes into action and the particles stick together. Thus spongy flocs are formed, which build up a spongy sediment similar to that just described, but with a floc in place of each grain. The resulting structure may be called a spongy structure of the second order (lower right, Fig. 5). Maximum void-ratio corresponding to a simple spongy structure being 4, the maximum void-ratio of this last type ought to be about 4^2, or 16, corresponding to a volume of voids of 94 per cent.

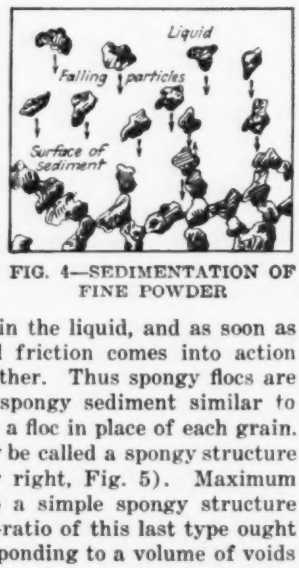


FIG. 4—SEDIMENTATION OF FINE POWDER

Thus we can explain item (1) of the list of differences between sand and clay merely by the difference in grain size.

Sedimentation tests with powders of different fineness (extracted from mixed-grain aggregates by wet mechanical analysis) gave support to this explanation. As diagrammed in Fig. 6, fine powders even when thoroughly consolidated by jarring could not be reduced to the denseness of coarser sediments loosely deposited. This fact gives us an idea of what an important factor initial friction is, provided the number of points of contact per unit of volume of the sediment is very great. These sedimentation tests were made in test tubes 1.6 cm. in diameter. Slow sedimentation in wider vessels would undoubtedly lead to smaller values, yet the test results can be taken as confirming the explanation.

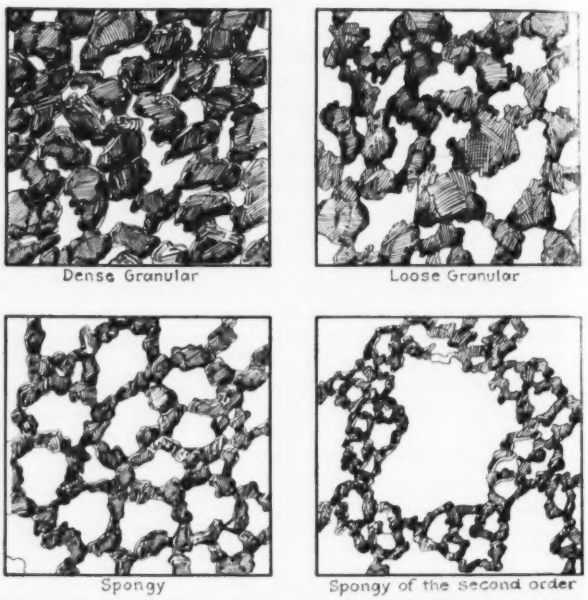


FIG. 5—MAIN STRUCTURE TYPES OF HOMOGENEOUS SOILS

Difference in Shrinkage—If a piece of clay dries, it shrinks; the voids of the clay remain filled with water until the shrinkage limit is reached. In a previous article it was shown that the shrinkage represents the compression produced by the capillary pressure, and that the maximum intensity of the capillary pressure (*transition pressure*) depends on the grain size. In terms of the maximum height h in meters to which water can rise in the mass by capillarity, the transition pressure in kilograms per square centimeter is $0.1h$. For a very fine sand h is approximately 0.05m. hence the transition pressure would be 0.005 kg./cm.^{2}, while fat clays have transition pressures of 200 kg./cm.^{2} and more. A pressure of 0.005 kg. per cm.^{2} cannot possibly produce any noticeable compression of the material. This fact accounts for item (2) of the list of differences between sands and clays.

Cohesion—Item (3) is also readily accounted for, since the maximum cohesive (shearing) strength of a grain aggregate is equal to the product of the transition pressure by the coefficient of internal friction of the material, so that sand cannot exhibit much cohesion.

Plasticity—A fact rather more difficult to understand is that colloidal quartz powders (microscopic sands) have no plasticity, while clays of equal fineness are very plastic. A body is plastic if its shape can be changed while its volume remains constant. To perceive the reason why microscopic sands are not plastic, the reader must refer back to the well-known sandbag experiment performed by O. Reynolds (*Phil. Mag.*, 1885). Rey-

*The term initial friction as used by the author denotes the shearing strength of the clay when not under pressure, either external or capillary.

nolds observed that a rubber bag full of dry sand opposes small resistance to change of shape, while if the bag is sealed after the voids of the sand are first filled with water it becomes as hard as stone and can be loaded heavily without changing shape. This fact is obviously due to the bulky shape of the sand grains; the arrangement of such grains cannot possibly change unless the grains roll over each other, and these grain movements are possible only when the structure temporarily becomes very loose, which would involve increase of the volume of voids. In a dry sand there is no obstacle to change of volume of voids, but when the voids are completely filled with water, and in addition air is prevented from entering, the volume of voids must remain constant; hence the grains cannot move and the content of the rubber bag makes the impression of being solid.

The nature of this phenomenon does not depend on grain size, provided the structure of the sand is not spongy but granular. A sediment consisting of a colloidal quartz powder is originally spongy and in this state is mobile, just the same as a spongy clay sediment;

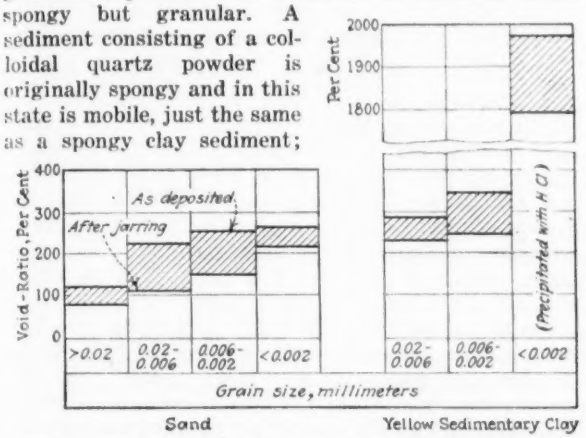


FIG. 6—VOID-RATIOS OF CLAY AND SAND SEDIMENTS

but when the capillary water of the quartz powder is allowed to evaporate, capillary pressure compresses it to granular structure. In this state, because of its bulky grains, it cannot change shape without changing volume, as shown by Reynolds' experiment. Hence neither sands nor colloidal powders with bulky grains are plastic.

In the case of clay, though held by the surface tension of the capillary water just as firmly as if enclosed in Reynolds' rubber bag, the particles are scale-like, and therefore can slide over each other while the volume of voids remains practically constant. Therefore clays are plastic. Item (4) of the differences between sands and clays is thus accounted for as the effect of size and shape of particles.

Naturally, as difference of grain size and form is one of degree, we may expect to find materials of various degrees of plasticity between the extremes of the non-plastic and the highly plastic. The most suitable method for expressing the degree of plasticity is that proposed by Prof. A. Atterberg, as already explained. Table I contains a list of the characteristic limits for colloidal powders produced by crushing and grinding different minerals. The degree of fineness of all the powders used in the tests was approximately the same. The table shows clearly the intermediate stages between high plasticity (talc, biotite) and complete lack of plasticity (colloidal quartz powders). For powders derived from the same material, plasticity was found to increase with a decrease in average size of grains.

TABLE I—PLASTICITY OF FINE MINERAL POWDERS

(Grains smaller than 0.002 mm. Figures from Atterberg's "Die Plastizität und Bindigkeit der Tone," *Internat. Mitt. für Bodenkunde*, 1913. The tabulated figures are moisture content in per cent of weight of solid matter.)

Mineral	Lower Limit of Plastic State	Lower Limit of Liquid State	Coefficient of Plasticity (=Difference of Two Preceding Columns)
Biotite	44	87	43
Talcum	48	76	28
Chlorite	47	72	25
Kaolinite	43	63	20
Hematite	20	36	16
Limonite	27	36	9
Quartz	35	35	0

Settlement—Coming to item (5), we again find grain size and shape to furnish a complete explanation. Loading the horizontal surface of a water-soaked layer of sand produces almost instantaneous settlement because the excess water finds small resistance to its escape from the compressed material; but in clay the low permeability causes an enormous resistance to escape of the capillary water, and therefore settlement under load proceeds slowly.

Hoover's Waste-Reduction Program Reviewed

IN HIS annual report for the current year Secretary of Commerce Hoover records the following outline of the policy which he inaugurated four years ago:

1. Elimination of waste in railway transportation by the provision of adequate facilities and better methods.
2. Vigorous improvement of our natural interior water channels for cheaper transportation of bulk commodities.
3. Enlarged electrification of the country for the saving in fuel, effort, and labor.
4. Reduction of the periodic waves of unemployment due to the booms and slumps of the "business cycle."
5. Improved statistical service as to the production, distribution, stocks, and prices of commodities, both domestic and foreign, as a contribution to the elimination of hazard in business and therefore of wasteful speculation.
6. Reduction of seasonal employment in construction and other industries, and intermittent employment in such industries as bituminous coal.
7. Reduction of waste in manufacture and distribution through the establishment of grades, standards of quality, dimensions and performance in nonstyle articles of commerce; through the simplification in dimensions of many articles of manufacture, and the reduction of unnecessary varieties; through more uniform business documents such as specifications, bills of lading, warehouse receipts, etc.
8. Development of scientific, industrial and economic research as the foundation of genuine labor-saving devices, better processes, and sounder methods.
9. Development of co-operative marketing and better terminal facilities in agricultural products in order to reduce the waste in agricultural distribution.
10. Stimulation of commercial arbitration in order to eliminate the wastes of litigation.
11. Reduction of the waste arising from industrial strife between employers and employees.

The major part of the report is devoted to a detailed statement by bureau heads of the progress made toward carrying out each of the above noted parts of this program. This progress, which has been reported from time to time in this journal, is impressive.

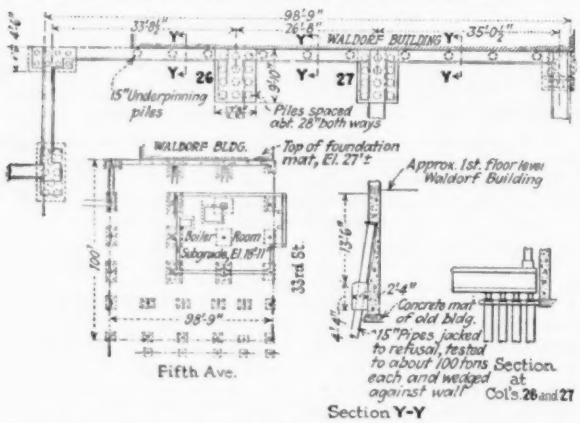
Work Started on Storage Reservoir in Ontario

Construction is under way on the $500,000 storage and power dam on the Mushkosh River in the Muskoka Lakes district of Ontario. This work is designed to control the flow from the Muskoka Lakes basin and to link up this power with the Eugenia-Severn system.

Inclined-Pile Underpinning for Special Condition

Method Devised to Avoid Disturbing Mat Foundation of Twelve-Story Building Resting on Wet Fine Sand and Clay

SPECIAL underpinning methods were developed in preparing for the construction of a new building at the southwest corner of Fifth Ave. and 33rd St., New York, where the old Cambridge Building is being replaced by the Astor Building. Adjoining the lot on the west is a 12-story structure, the Waldorf Building, supported on a concrete mat whose bottom is about 18 ft. below curb. While the basement of the new building is to extend only 13 ft. below curb, which places the new foundations above the bottom of the existing mat, there is a boiler room in the new building, about 18 ft. from the westerly lot line, whose subgrade will be 26 ft. below curb. Rock is from 35 to 45 ft. below curb, and the overlying soil is wet fine sand and clay, judged to be of such character as to necessitate underpinning the edge of the old mat foundation. The



FOUNDATION AND UNDERPINNING, ASTOR BUILDING

consulting engineers for the work, Moran, Maurice and Proctor, further believed it unwise to disturb the support of the mat in any way if it could be avoided.

Method of Underpinning—It was realized that a considerably greater degree of safety would be obtained if it were possible to underpin the wall without cutting into the mat, in view of the unreliable character of the underlying soil and of the probability of rather high loading under the edge of the mat. The sectional sketch herewith shows the solution worked out. Inclined pipes were jacked down just beyond the edge of the mat, at such an angle as to intersect the wall center line near the level of the first-floor beams. These pipes were put down to rock, were blown out and filled with concrete, and finally were extended by struts to seats cut in the masonry of the old wall in a line with the axis of the piles. The combination was wedged while the jacks were acting.

Foundation Plan Changed—The foundations of the new building are in general steel pipes 15 in. and 16 in. in diameter, driven to rock, cleaned out and filled with concrete. In the preliminary plan the pipes for the support of the columns adjoining the mat were in two rows parallel with the lot line, thus making long narrow foundations concentric with the column centers and avoiding expensive cantilevering. When excavation was started it was found that the material was of a poorer character than that indicated by the test borings, and it was decided that the greatest care should be used to prevent possible damage to the Waldorf Building. To this end the arrangement of the adjacent piles was reversed, putting the long axis of the unit at right angles to the lot line, so as to reduce to a minimum the number of piles close to the mat and consequently the amount of vibration (due to driving the pipes) adjacent to the mat. This change made it necessary to resort to cantilever support of the columns, at increased cost, but the increase was considered justified by the gain in safety.

Charles A. Platt is architect for the building, H. G. Balcom is structural engineer, and Marc Eidlitz and Son, Inc., are the general contractors. Spencer, White & Prentis were the contractors for the underpinning, which has just been completed.

Further Irrigation Development Desirable

AFTER two years' study of the question whether irrigation in California is overdeveloped, and whether new irrigation enterprises should be encouraged or discouraged, a joint committee of the irrigation section of the Commonwealth Club (San Francisco) and of the San Francisco section of the American Society of Civil Engineers reports in favor of continued irrigation development without regard to the admittedly large surplus of idle irrigated land. The committee concludes, "Where local areas have feasible opportunities for irrigation which they desire to develop, there is nothing in a general situation in regard to irrigation which should discourage such development." But they caution that "general or artificial stimulation of irrigation expansion should be carefully guarded against. Development costs should be kept well within the capitalized value of the net income practicable to obtain from ordinary farming operations—in general from diversified farming and field crops except in localities of proven advantages for specialized crops such as fruit or vine."

As an aid to sound development of irrigation, the committee recommends continued state investigation, particularly of water resources and their development. It asserts that not all of the projects now in operation were justified or are successful, and points out that there is need for careful study and stimulation of wisely guided land colonization in connection with many irrigation projects.

Statistics compiled by the committee indicate that (1924) California had irrigation works constructed and a water supply provided for about 5,900,000 acres of land, of which only 4,720,000 acres or 75.5 per cent were irrigated, so that 1,155,000 acres are idle though provided with irrigation facilities and water supply. The percentage of cultivated land for all of the irrigation states (1920 figures) is 73.9, with a total of 26,000,000 acres provided with water supply and about 19,200,000 acres actually irrigated and cultivated. The committee considers that on the basis of actual development history, an idle margin of about 25 per cent of uncultivated land seems normal and should not be considered as a discouragement to further irrigation.

The joint committee was headed by Fred H. Tibbetts, and included B. A. Etcheverry, Thomas H. Means, C. H. Lee, J. R. Mason, W. A. Beard, and S. T. Harding.

Road Progress in the South Atlantic and Gulf States

South Carolina	Louisiana
Georgia	Florida
Alabama	Mississippi

An Editorial Field Study of State Road Organization, Policies and Plans; the Trend of Highway Thinking; the Status of State Control; and the Progress in Engineering and Construction in Six Southern States

BY JOHN W. SHAVER
Assistant Editor, *Engineering News-Record*

Public roads present a deeply interesting study in the six Atlantic and Gulf Coast states considered in the series of articles which begins here. Nowhere in the United States has the inauguration of road improvement been more tardy. Nowhere has local control of roads offered a more sturdy resistance to abolition. Nowhere has federal-aid road legislation been a greater force for the betterment of highway practices. All these facts stand out in the articles and give them their group characteristic.

To get centralization of direction and to get money for improvement have been the great highway tasks of every far southern state. The money has come more easily than the agreement to release local rights. From vehicle licenses and gasoline taxes in recent years there have been comparatively large sums available for road improvement. The control of this money by the state highway commissions has, however, met persistent objection. The people have required the division of road income among the counties, and this of course means similar division of control of road improvement. The articles indicate how, gradually, the state highway departments have been freed of this subordination. Their liberty is still far from complete but this is a status not confined to the states of the far South. Altogether in the South, as all over the country, there is increasing centralization of state roads direction.

In road building in the South the physical task has been primarily to gain mileage and to keep it well maintained. The articles bring out clearly the progress that has been made. While the mileage of paved road is insignificant in any of the states considered their mileages of maintained graded and surfaced highway are considerable. In engineering and construction the state-built roads rank with roads of their class anywhere.

Finally the articles demonstrate the force of federal aid in elevating the standards of state highway administration. The modernization of public roads financing, system development and management in the South is contemporaneous with federal aid.—EDITOR.

I—South Carolina

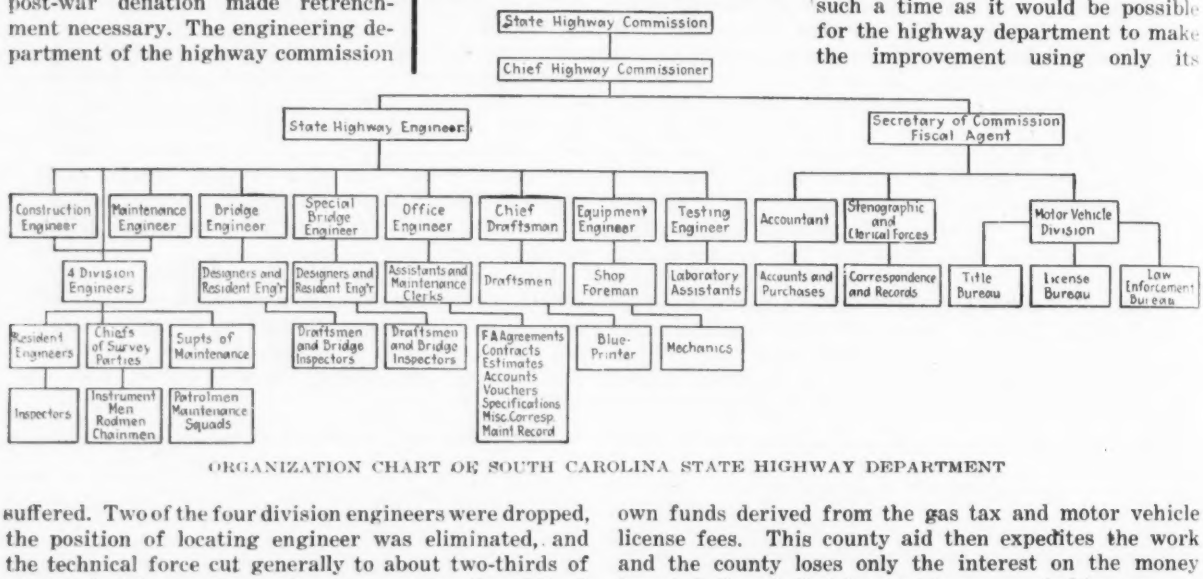
STATE highway development in South Carolina dates from the passage in 1916 of the Federal-Aid Highway Act. Before that time all of the road improvement in the state had been carried out by counties and townships. But prior to the organization of the state department there had been considerable agitation, fostered by automobile and civic associations, for an interconnected state system. When the federal government, therefore, held out its offer of assistance providing the state met certain financial obligations and conceded certain technical supervision, South Carolina passed its first state highway act in 1917. The main provisions of that act were the designation of a highway commission of five members, three of whom should be the heads of the engineering schools at the state's three principal colleges—University of South Carolina, Clemson and The Citadel—and the designation of financing methods of federal-aid construction. As no state funds were available from bond issues the legislature provided that 20 per cent of the tax raised from motor vehicle licenses should go to the operation of the highway department, the other 80 per cent being returned to the counties for whatever use they wished to make of it. This return to the counties was made on the basis of the number of vehicles in each county paying license fees. Money actually to meet federal funds was supplied by the counties. *The first state highway commission therefore was organized primarily to co-operate with the counties* in the expenditure of their funds on an interconnected system. The first highway law had stipulated that the system be made up of roads connecting all county seats and the main lines of travel. Though that first commission had not been given the specific authority so to do, it made a general designation of what the state system should contain. This was done as a matter of convenience in the expenditure of funds, and that system followed the routes of heaviest traffic between county seats.

Highway Law Changes—The commission of 1917 functioned for three years, though its activities were largely curtailed during the war when construction equipment and materials were shunted to the proper prosecution of the war. At the close of the war a reorganization of the highway department was made. The legislature of 1920 amended the original highway law so that the personnel of the commission was increased to seven members—one from each congressional district in the state—and authorized the designation of a state system and made certain additional financial provisions. Twenty per cent of motor vehicle license taxes was still allotted to the operation of the state highway department, but the other 80 per cent was given the state highway department for maintenance. The maintenance had to be carried on, however, in the counties in the proportion of the registration of their motor vehicles. This part of the law,

then, simply designated that the 80 per cent should be returned to the counties in the way of maintenance under state supervision. Money for new construction and to match federal aid was still supplied by the counties.

Pursuant to the authority for a system of designated routes hearings were held during the early months of 1920 in all the county seats in the state, and a designated system agreed upon by state and counties. That system was published later in 1920 and has remained as originally designated, with the exception of a few additions. Also, the engineering organization of the department was formulated practically as it now exists after the passage of the 1920 law.

In 1922 the state started its budgeting of all finances. During the previous year the boll weevil had been particularly active and cotton crops had been greatly affected. The combination of bad crops and a general post-war deflation made retrenchment necessary. The engineering department of the highway commission suffered. Two of the four division engineers were dropped, the position of locating engineer was eliminated, and the technical force cut generally to about two-thirds of what it had been. Money for new construction fell off somewhat. However, in 1924 conditions were somewhat brighter and a new highway law superseded the 1920 law. By that latest law the supervisory force recaptured practically its original 1920 organization, and, with the addition of a chief highway commissioner, a paid officer, authorized in 1925, became the organization shown on the accompanying chart.



ORGANIZATION CHART OF SOUTH CAROLINA STATE HIGHWAY DEPARTMENT

Origin of Funds—The law of 1924, with certain amendments added by the legislature of 1925, is what is known as the "Pay-As-You-Go" law. By its terms all payment for new construction by the counties without reimbursement from the state ceased. A three-cent gasoline tax was passed at that time and one cent of the tax money was given the state highway department. The other two cents were divided between the state's general fund and the counties. In 1925 the gas tax was raised to five cents and the state highway department was given three of the five, the other two going to the counties on the basis of mileage of roads each had in the state system.

The 1924 law also gave all of the motor vehicle license tax to the state highway department. This, combined with moneys derived from the gasoline tax, amounted during the first ten months of 1924 to more than $3,000,000. With incidental funds and federal aid the total available for construction and maintenance during that period exceeded $4,500,000. The 1924 law also again designated the routes upon which money should be spent, always considering the needs of intercounty travel. The state system now comprises approximately 4,700 miles, 4,200 of which are under maintenance, 3,200 of which are improved, 300 paved, 50 miles surface treated and 60 miles under contract to pave.

Law of 1924—The greatest step toward complete control of a state highway system by the state was made by the provisions of the 1924 law. By its terms counties shall be reimbursed for all money spent on new construction within such counties, except for emergency surface treatment of roads and the construction of emergency bridges. The counties still advance the money for construction but they are reimbursed (in equal installments covering a period of years) within such a time as it would be possible for the highway department to make the improvement using only its own funds derived from the gas tax and motor vehicle license fees. This county aid then expedites the work and the county loses only the interest on the money invested, though that interest is represented in a new or improved highway structure. All contracts made by the state highway department stipulate the amount which the contractor can collect from the state and that which the county must pay. Each such contract is signed by both state and county officers. Separate provisions for reimbursement are made between state and counties.

Another provision included in the 1924 law was the extension in size of the highway commission. It was believed that with the entire motor vehicle funds and part of the gas tax going to new construction and maintenance there would be a considerable quickening of highway construction. Because the counties had been so linked with highway improvement theretofore, a larger and wider representation on its supervisory body was thought advisable. The commission was increased to fourteen members—one from each of the circuit districts. The extension of the commission was made in all good faith by the legislature, but it was not foreseen how unwieldy such a large body could be. Leadership among seven men is much easier than among twice that number. And that is now becoming apparent. It is possible that the commission will involve itself in endless debates rather than accomplish

necessary departmental routine. It is generally felt that the organization of the commission is not in its permanent form. The South Carolina commission is the largest in the United States, and since there is no precedent for so large a body it is conceivable that a change is inevitable.

Executive Officer Appointed—The 1925 legislature added another feature to the state highway organization. It authorized the appointment of a chief highway commissioner who should be the administrative and executive head of the commission when that body was not in session. He is a paid officer, the salary being $6,000 annually. The present incumbent is Samuel McGowan, retired rear-admiral of the U. S. Navy, who was retired before the age limit as recognition for his distinguished services in the bureau of supply and purchase during the war. Admiral McGowan is serving without pay. Though there has grown up that opposition to his position which might be expected when such broad powers are centralized, his tenure is generally popular. Though the character of the commission may change it is believed that a business manager is needed, so the position of chief highway commissioner seems a secure one.

There has been considerable opposition to the pay-as-you-go plan of highway financing in South Carolina. In fact a bond issue which called originally for the expenditure of $40,000,000 was considered in the latest session of the legislature. It was passed after some amendment by the Senate but the house killed the bill. The whole support and opposition of both methods of financing state highways is bound up with the general economic situation. General deflation has been bad on the banks of the state. Poor crops have added to their burden. Real estate values have ebbed, so that at bottom it is perhaps unwise for the state to consider unusual expenditures for highway betterments. General preference is had, rather, for a scheme of indirect taxation, such as on gasoline, tobacco, cigars, cigarettes (there is a two-cent tax on these per package), candy and soft drinks. The latter, known as "nuisance taxes" are under general public censure. Tax reform is being talked widely. The next session of the state legislature will have a knotty problem to arrive at any happy medium. But automobile owners want roads. They seem not satisfied with the great strides made so far in keeping practically the entire system under constant maintenance, and the improvement of three-fourths of that system.

Construction Proposals—Anticipating what the next session of the legislature will want in the way of information the state highway engineer, Charles H. Moorefield, who has been in that office for the past five years, has prepared a plan of proposed construction which contemplates the use of funds derived from federal aid, automobile licenses and gasoline sales. Beginning this year there is contemplated the expenditure of $70,000,000. Expected receipts are $1,000,000 yearly from the federal government, $25,000,000 from motor vehicle license fees (ranging from $1,700,000 for 1925 to $3,300,000 for 1934) and $35,000,000 from the sale of gasoline (ranging from $2,400,000 for 1925 to $4,600,000 for 1934). This will yield a yearly total ranging from $5,100,000 this year to $8,900,000 for 1934. The proposal is to use $2,000,000 of this sum yearly for maintenance, $200,000 yearly for betterments, $250,000 yearly for the operation of the highway department, $200,000 annually for reimbursements to the counties, from $500,000 for 1925 to $1,250,000 for 1934 for bridges and from $1,950,000 for 1925 to $5,000,000 in 1934 for roads, including new construction and improvement. Should federal aid be withdrawn or the gasoline tax be repealed the state would then have to look to unusual measures for its highway funds.

Strength of County Influence—Because state administration of highways is so linked up with county needs, the law of 1924 made some unusual stipulations. For instance it is agreed that no county shall have two paved roads until every other county shall have had at least one. That means paved roads built by the state. In order to build up a connected system it is probable that counties will have to do some of their own construction. In explanation of the plan for the expenditure of $70,000,000 in the next ten years, Mr. Moorefield has made an exhaustive report on just what projects in each county should be benefited in each of those ten years. Three plans of apportionment have been devised. To denote how strong county control still is, part of that report of Mr. Moorefield's is here abstracted:

1. The first scheme is based on making the distribution among the counties, one-third in the ratio of the motor vehicle revenues; one-third in the ratio of the assessed valuations; and one-third in the ratio of the land areas.
2. The second scheme is based on making the distribution among the counties one-third in the ratio of the motor vehicle license revenues; one-third in the ratio of the road mileage and one-third in the ratio of the land areas.
3. The third scheme provides for one-half of the fund to be distributed among the counties in the ratio of the motor vehicle revenues and one-half in the ratio of the road mileage in the state highway system.

It is recommended that the commission adopt as a guide the first scheme of apportionment to be followed from 1927 to 1930, inclusive, and then shift to the third scheme from 1931 to 1934 and also adopt some such program of construction with the idea that the schemes of apportionment will not only be followed insofar as they conform to the construction program but that they will determine the order of precedence in undertaking work. It is also recommended that when the program is complete in any county within the apportioned funds, then subsequent allotments becoming available would be used in extending the construction to projects in adjoining counties, or in other words to move up the order of precedence of those roads outside of the county in which the county should be particularly interested.

Inasmuch as but 300 of the 4,700 miles in the state system have so far been paved, it is reasonable to ask where the principal work is being done. It is in the improvement of the dirt roads. Practically 3,200 miles, or about three-fourths of the state system, have been improved. The two prevailing types of improvement have been sand-clay and top-soil, with some gravel. Sand-clay roads are built of selected roadside materials. The road is graded and shaped and sand and clay spread and allowed to consolidate under traffic. Such roads are found mostly in the eastern part of the state. With constant dragging and spreading of new material at least once a year, the roads are kept in excellent shape. With proper care and attention such a road can be kept from rutting. In fact in most seasons of the year there is a decided metalled appearance to the road. But the roads must be dragged after every rain and as soon as the top shows signs of wearing out and shredding new material.

with better cementitious qualities, must be spread after the dead soil has been winnowed to either side of the road.

Construction Types—Top-soil roads are found in the western part of the state, and are given constant maintenance in dragging. There is a good grade of top-soil locally available which is spread on the graded and shaped road and consolidated under traffic. Much the same treatment is given both types, the quality of the material alone differing. Top-soil is paid for in place and sand-clay in the pits. Gravel roads are made of materials hauled from the five or six deposits found in various parts of the state.

Paving divides between cement concrete and asphaltic concrete with some sheet asphalt. Both types are laid on a concrete base. Concrete bases are built of a 1:3:6 mix and concrete surfacing of a 1:2:4 mix with 6-in. center and 8-in. edges. Concrete paving is laid without reinforcing, and with expansion joints every 40 ft. Asphaltic concrete is 2 in. thick on a 5-in. concrete base. It is laid in competition with portland cement concrete.

There are a few miles of surface treated roads, the treatment consisting in the application of cold tar (about 0.3 gal. to the sq.yd.) and on top of that hot tar. The latter is put on in the proportion of 0.5 gal. to the sq.yd. The top surface is then spread with small stone. It is believed that fair results can be obtained from such a road if treatment is given every two years. The road looks like a bituminous macadam. Considerable research has been carried on in the matter of surface treatment, but so far no results obtained which would guarantee good wearing qualities at small cost over a large mileage.

Maintenance—All maintenance is handled through the four division engineers. There is a maintenance engineer at the central office, but the actual work is controlled by the division engineers. Under the division engineers are maintenance supervisors. Maintenance superintendents actually superintend the work. Maintenance is by gangs for unusual repairs and by patrol for ordinary work. There is a motorized patrol outfit for each 18 miles of road. Practically all of the maintenance equipment is motorized, though there is some team hauling of materials. All of the dragging and machining is done with motor equipment.

The work which the department so far has done has been remarkable. It has at least given the public roads upon which it can travel at all seasons of the year. It has provided routes (notably that crossing the Santee River flats) formerly uncertain because of floods. And until last year it had done these things with no money of its own and with an eye single to the needs of inter-county travel.

Finally, the department is up against the necessity of harmonizing county and sectional wishes with a plan that will give the state the best system of interconnected highways. It cannot overlook political expediency. And it cannot afford to harken too much to sectionalized demands. The position of its officers is a difficult one. It has a taxation problem which is particularly acute in South Carolina. But, granting these things, the state is getting somewhere with its roads, though it may not be breaking world's records in paving construction.

Some Recent Studies in Effect of Alkali on Concrete

Review of the Work Being Done at University of Saskatchewan by Canadian Research Interests

By C. J. Mackenzie
Dean of Engineering, University of Saskatchewan, Saskatoon, Sask.

Abstract of paper published in "The Engineering Journal" of the Engineering Institute of Canada, November, 1925.

For the past three years Dr. Thorvaldson, professor of chemistry at the University of Saskatchewan, has been directing a chemical research into the disintegration of cement in so-called alkali waters. This work has been done under the auspices of a research committee of The Engineering Institute of Canada with the financial support of the Research Council of Canada, the Canada Cement Co., the Canadian Pacific Ry., and the Prairie Provinces of Canada. A great deal of very valuable work has been done and many deductions important from the practical as well as the scientific standpoint may now be made.

It may be stated that Dr. Thorvaldson suggests a general explanation of what happens when cement is acted upon by solutions of sodium and magnesium sulphate, which salts it is generally accepted are the constituents of so-called alkali waters chiefly responsible for the decay of concrete. This explanation, no less striking in its simplicity than in its novelty, is supported by unquestioned experimental data and accounts for many effects which have been observed for years by different engineers, but which were never explained. For instance, it has been observed and reported by many different engineers that when concrete is mixed with or cured in sulphate waters, setting of the cement is not hindered, and the strength during the first few weeks is not below the normal. While most engineers have reported only the conclusion that early strengths were not decreased by contact with sulphate waters, other engineers have noted that the original test data actually indicated a slight increase in the early strengths. Dr. Thorvaldson's explanation of sulphate action shows clearly that this early increase in strength is to be expected.

Another interesting conclusion from the experimental data is that if pure water only be permitted to percolate freely through a porous concrete, the cement will eventually become completely disintegrated, just as it would if immersed in a solution of sodium sulphate.

Alkali Action—A very important finding is that of the fundamental difference between the actions of sodium sulphate and magnesium sulphate on cement. Hitherto it has been quite generally accepted that the so-called alkali action could be regarded as the action of either sodium or magnesium sulphate or of a mixture of these. It is very significant to note that not only has Dr. Thorvaldson proved that the chemical actions of these two salts on cement are different, but he has found that certain cements, which are disintegrated in sodium sulphate, will apparently stand up in magnesium sulphate; he has also been able to produce a treated cement which has stood up in sodium sulphate solutions but will not do so in solutions of the magnesium salt. Up to the present time, however, no cement has been produced that will stand up in both under the most adverse conditions. This distinction between the actions of these two sulphate salts should be kept clearly in mind when drawing general conclusions from the results of particular exposure tests, especially as in many of the alkali waters, magnesium sulphate is the principal sulphate, just as it is in sea water, while in other alkali waters there is a preponderance of sodium sulphate. It may be mentioned that, while we feel quite certain that the sodium and magnesium sulphates are the salts chiefly responsible for the disintegration of concrete, studies are also being made on the actions of other sulphates on cement.

A still further result of the work to date, which appeals to the practical engineer as of great importance, is that we are now able by chemical analysis of the disintegrated concrete to determine definitely whether the cause of failure has been (a) alkali action, (b) acid action, or (c) frost

or weather action. The non-conclusive nature of a diagnosis based on a physical examination only has been the cause of much difference of opinion in the past and for years retarded actual work of an investigational nature, due to lack of unanimity in accepting the problem.

Old Theories—The theories of sulphate disintegration of concrete date back about a hundred years. At that time L. J. Vicat explained the disintegration of hydraulic cement in sea water as due to the action of sulphate of magnesia on the uncombined lime in the cement forming sulphate of lime, this substance being dissolved and carried away if the water "traverses the mortar or concrete rapidly," while if the water passes through very slowly crystals of gypsum are formed in the mass causing the expansion of the mortar characteristic of mortars decomposed by sea water. This explanation with certain modifications is still accepted for the disintegration of cement in sulphate waters in general.

Modern hydraulic cements, if properly made, do not contain free lime. However, during the process of normal hydration, free lime is liberated and the past theories have assumed that the interaction of the sulphates in the water with the calcium hydroxide liberated during hydration forms gypsum crystals and that the force of expansion due to this crystallization shatters the cementing materials. A further development of this idea attributes the chief cause of disintegration to the formation of calcium sulpho-aluminate through reaction between the calcium sulphate and the hydrated tricalcium aluminate of the cement. This product, which crystallizes with 30 molecules of water and with a large increase in volume, is supposed to form cracks in the hardened mass which admit more of the sulphate water, the crystals then increase in size and "with irresistible power cause the mortar to burst more or less completely."

Thus the current theories as stated above claim that disintegration is primarily due to a direct chemical action between the sulphates and the different ingredients of set cement. Now the explanation of sulphate action on cement proposed by Dr. Thorvaldson does not suggest that the above mentioned reactions or similar ones do not occur, but it does say that these are secondary and that the primary action has to do with the hydration of the cement. It is shown that the presence of sulphates during the setting of cement assists and speeds up the necessary hydration of the cement, and that this would naturally give strengths higher than normal during the initial stages, such as have been observed in the field, but unfortunately the hydration or hydrolysis does not stop at the point of optimum strength for the cement, as it ordinarily does in pure water, but it is carried on and on until so much of the calcium has been removed by hydrolysis that sufficient strength to withstand the physical action of crystallization is gone.

The reason that hydration stops under normal conditions is that as hydration proceeds with the liberation of $Ca(OH)_2$, the immediate film of liquid around each particle of cement reaches saturation and finally what is known as chemical equilibrium obtains, no further hydration occurring. Now if for any reason this saturated film is removed equilibrium will be upset and hydration will proceed beyond the point of optimum strength. If this view is correct then constant passing of pure water through a porous concrete would keep this saturated film of $Ca(OH)_2$ from forming and should upset the equilibrium and permit hydration to proceed until complete failure of the cement occurs. Experiments in the laboratory have proved this to be the case. It will be noted that the disintegration of porous concrete in dams and other hydraulic structures where water is forced through concrete at a comparatively high rate, may thus be viewed in a new light.

Structures Observed—Engineers will be interested in learning that two different hydraulic structures of large magnitude, inspected about three years ago by Dr. Thorvaldson showed marked signs of water seepage. The concrete appeared to be of good quality and the water that was being forced through was not alkali but fresh river water. One of these structures had suffered serious disintegration, which could not be satisfactorily explained at that time, the second structure showed then no serious action. Samples taken at that time showed large accumulations of $Ca(OH)_2$ on the outside surface of both structures. It is plainly evident now in the light of the above explanations, just why disintegration should be expected in such cases, and it has been recently learned unofficially that the second structure which was apparently sound three years ago is now occasioning serious alarm.

When set concrete is exposed to sulphate solutions (or alkali waters), the same general action takes place that occurs when pure water is forced through concrete, only the liberation of lime is speeded up by the presence of the sulphate and then the equilibrium is upset by the saturated film of $Ca(OH)_2$ solution combining with the sulphate solution, with the consequent result that hydration of the cement proceeds further and if enough sulphate is present complete failure will result.

During this process crystals of gypsum separate out in the concrete, and the calcium sulphate reacting with the hydrated calcium aluminate forms calcium sulpho-aluminate. The disruptive force of crystallization may be a factor in the final crumbling especially where alternate wetting and drying take place. Dr. Thorvaldson's results indicate also that in the advanced stages of sodium sulphate disintegration, if the concentration of the sulphate is high and drainage is poor, reactions will occur directly between the sodium sulphate and the hydrated aluminates and silicates. Thus it may be true that final disintegration in such cases is the result of direct attacks on some of the fundamental primary constituents of the set cement. However the important point to realize is that Dr. Thorvaldson has shown quite conclusively that in the early stages at least, the primary action of sulphate solutions on concrete consists in speeding up the hydration (with a consequent strength increase in the early stages) and by not permitting the hydration to stop at the point of optimum strength, creating the conditions leading to final destruction of the cement. Another valuable bit of evidence to support this theory lies in the success of a remedy tried. A substance was added to cement which had for its function the maintaining of equilibrium at the optimum point. Treated bars of porous sand mortar (1:7½ mix) have been standing up in a 2 per cent Na_2SO_4 solution for nearly two years now, whereas untreated bars under the same exposure conditions are completely destroyed in ten to fifteen days.

The difference between the reactions of sodium and magnesium sulphate on cement has been ascertained both by chemical and petrographic methods and is of great importance, for if a general remedy is to be found it must be possible to maintain the proper equilibrium under two different chemical environments. The different character of the disintegrated cement due to the different sulphates explains also the difference that has been noted so often in various concrete structures, some of the decay being soft and putty-like, into which a pick could be driven, while in other structures the concrete has appeared to scale off and crumble with the production of granular decomposition products.

Achorutes Viaticus Die at Singapore

An attempt to colonize sewage sprinkling filters at Singapore with achorutes viaticus imported from the sewage works of Barnsley, England, proved unsuccessful, according to an article in the London *Surveyor* of Aug. 28, abstracted from the 1924 annual report of David B. McLay, executive engineer to the city of Singapore. The insects were "put up in tins [cans] containing fine material similar to that used in the Barnsley filters. The cans were put in cold storage aboard ship for transport, and "small quantities of tank effluent were fed to the insects each day, or as often as necessary." The insects appeared to be in good condition on arrival at Singapore but within two days thereafter had died, although they had been applied to experimental filters supplied with "tank effluent." The *Surveyor* paraphrases Mr. McLay's comments on the attempt as follows: "Had the propagation of these insects been possible the whole of the material in the old filter beds would have been cleaned without the necessity of removal; and the new filters would have been safeguarded against clogging for all time."

Atlanta Now Sells Excess Steam from Refuse Incinerator

Of Nearly a Pound of Steam Per Pound of Refuse 36 Per Cent Used for Works Purposes and 64 Per Cent Sold for Use in Making Gas

By H. J. Cates
Superintendent of Refuse Incinerator, Atlanta, Ga.

After wasting for a dozen years such of the steam produced by the garbage and refuse incinerator as was not utilized for plant operation the city of Atlanta, Ga., began selling steam to the local gas company on Jan. 7, 1925, under a ten-year contract. For the four full months, February to May, the city delivered 24,783,600 lb. of steam to the company, out of a total output of 38,762,600 lb. The remainder, or 36 per cent of the entire steam production, was used for plant operation, including the lifting and conveying of the mixed refuse from the underground storage pit to the charging floor of the incinerators. During the four months the delivery of refuse to the pits totalled 39,748,235 lb. With no allowances for pit drainage or other losses, or for some 120 tons of refuse a month used to get up steam after cleaning the furnaces, nearly a pound of steam was produced for every pound of refuse delivered to the pits during the four months, while in February the rate was 1.14 lb. of steam per pound of refuse.

The incinerator was put in operation in August, 1913, with a rated capacity of 250 tons per 24 hours. The composition of refuse on which the guarantees were made is 40 per cent garbage, 30 per cent rubbish and trash, 15 per cent manure, 15 per cent ash.

Each of the three units of the plant has three cells and each cell has a grate area of 22 sq.ft. Each feed door, grate, and clinker pusher is operated by an individual hydraulic ram under 1,500 lb. pressure. A turbine blower rated at 35 hp. at 2,400 r.p.m. is provided for each unit, also a boiler with superheater, rated at 9,000 lb. per hr. at 200 lb. pressure. Gases after leaving the boiler are passed through an air pre-heater before reaching stack; air forced around these tubes is heated to about 270 deg. F. before reaching the grates.

Auxiliary Equipment—Besides the three 35-hp. blowers there are two 35-kw. turbine generators, two boiler feed pumps, one high-pressure pump, one upright slide-valve engine and a steam shovel for loading clinker on trucks.

Refuse is hauled to the incinerator by trucks and carts, weighed and dumped into a 40x25x20-ft. storage bin. From this bin it is lifted 90 ft. by grab buckets then hauled to the hoppers above the grates by monorail cranes. Five buckets or charges (each charge weighing about 1,000 lb.) are dropped into each cell. When burned to a clinker the grate is backed from under it letting the clinker fall into a pit below the grate, from which it is pushed onto a car and carried outside the building. Clinkers and residue which average about 25 per cent, are loaded on trucks and used to make streets and fill large holes about the city.

After five charges have been dropped into a cell and the material is burning rapidly, steam is turned into a ½-in. pipe line placed on the under side of curbs (⅛-in. holes drilled 4 in. apart). This prevents clinker from sticking to the curbs and back wall and also increases the life of the curbs. The curbs are castings placed alongside the grate to form a division between the cells and are about 10 in. high.

Contract for Excess Steam—In the latter part of 1924 a contract was made between the Georgia Railway & Power Co. and the city of Atlanta for excess steam, the steam to be used at the gas plant of the company. The company agreed to lay a steam pipe from a header to the city's property line and to furnish and install meters at the incinerator. The city agreed to construct a line from its header and to the property line. The steam pipe is 8 in. in diameter and 1,650 ft. long and is laid underground along the railroad. The contract calls for a minimum steam delivery of 11,000 lb. per hr., the city to be paid 16c. per 1,000 lb. of steam up to 70,000,000 lb. and 20c. thereafter; for any deficiency in steam delivery, under the minimum clause, the city forfeits 4c. per 1,000 lb. Prior to the date of the contract no record was kept of the steam that was released to the atmosphere except at intervals when tests were run. The accompanying chart shows results of one of these tests with two units in use.

Steam was first delivered to the gas company on Jan. 7, 1925. The refuse deliveries, steam delivered to the gas company and used by the plant and its auxiliaries and related data are shown by months from January to May by the accompanying table. The figures given represent the steam generated with two units in operation, with refuse as was dumped into the bin and without the addition of any other combustible material. One unit was idle for want of refuse.

TABLE I — SUMMARY OF STEAM PRODUCTION AND SALE, ATLANTA GARBAGE AND REFUSE INCINERATOR, JANUARY TO MAY, 1925

Month	Refuse Delivered to Storage Bin, Lb.	Steam Generated in Pounds — Total	Steam Generated in Pounds — To Gas Co.	Steam Generated in Pounds — Used for Plant Purposes	Furnace Hours — Total	Furnace Hours — Lost for Lack of Refuse	Average Steam per Furnace Hour — Total	Average Steam per Furnace Hour — To Gas Co.
January	10,622,575	8,678,250	4,884,250*	3,794,000				
February	8,375,570	9,539,800	5,997,300	3,542,500	545	127	17,504	11,004
March	11,454,385	10,073,550	6,310,050	3,763,500	579	165	17,398	10,898
April	10,816,280	9,976,100	6,527,100	3,449,000	546	174	18,271	11,594
May	9,102,000	9,173,150	5,949,150	3,224,000	496	248	18,494	11,944
Totals, February to May	39,748,235	38,762,600	24,783,600	13,979,000	2,166	714	17,887†	11,432†

*No steam delivered to Gas Company until January 7. †Average for four months.

TABLE II—DAILY AND WEEKLY PAYROLL, ATLANTA INCINERATOR

	No.	Daily Rate	Daily Total	Days per Week	Weekly Total
Superintendent	1	$10.00	$10.00	7	$70.00
Engineers	3*	6.50	19.50	7	136.50
Stokers	6*	4.50	27.00	6	162.00
Cranemen	6*	4.50	27.00	6	162.00
Clinker men	6*	2.50	15.00	6	90.00
Cleaners	3*	2.50	7.50	7	52.50
Repair men	2	5.75	11.50	6	69.00
Shovel men	1	5.00	5.00	6	30.00
Dumper	1	2.50	2.50	6	15.00
	28		$125.00		$787.00

*Working in three 8-hour shifts.

With the addition of one man on each shift 75 to 80 tons more could be handled each 24 hours, with a corresponding addition to the steam flow and a large decrease in cost per 1,000 lb. of steam.

Operating Force—A superintendent and 28 men (24 of them divided into three 8-hr. shifts) constitute the operating force. The payroll totals $125 a day and $787 a week, there being but few men on duty seven days in the week. Table II gives payroll details.

Since temperatures vary largely with the quickness of combustion in fresh charges, much depends on how the charges are placed in the furnaces. It can be readily seen that, when trucks and carts are dumping into a deep pit, as the pile grows larger the light combustible material, such as paper boxes, trash, etc., will have a tendency to roll away from the wall toward the bottom of the pit, while the heavy and less combustible material like dirt, ashes, etc. will lie next to the wall. If the first two charges are taken at the bottom of the pit and the next three at the wall, combustion will start much more quickly and a much higher furnace temperature will be maintained than if this method is reversed. After many tests at all seasons we have adopted this method of charging furnaces and find it most satisfactory.

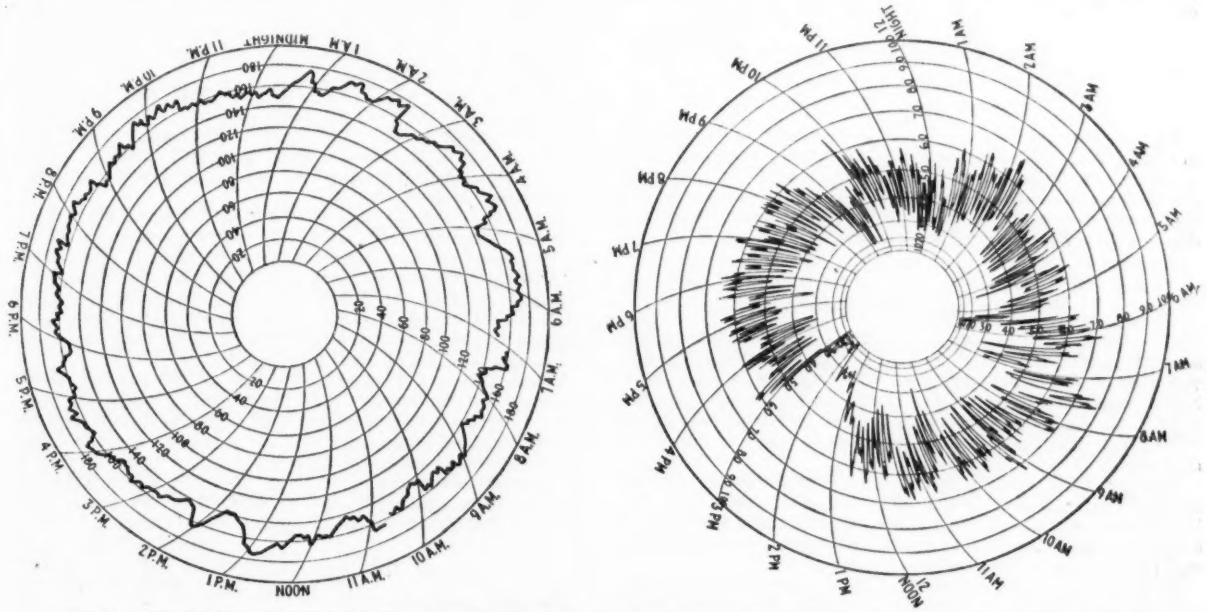
Brickwork in the furnaces has given very little trouble. This is due to the fact that fine particles of sand and dirt stick and form a protective coating. This grows to 8 or 10 in. in thickness and has to be picked off each year.

Grates give four to five years of service but curbs alongside and to the back of the grates have to be renewed each year and would have to be renewed more often than this were it not for the steam lines underneath them mentioned in another part of this aritcle.

Boilers have given excellent service with very little repairs necessary. Were furnaces and boilers equipped with automatic appliances, such as damper regulators, feed-water regulators, soot blowers, better results would be obtained.

Refuse incinerators are as a rule designed and built for specified percentages of garbage, manure, trash, ash, etc., and on these mixtures guarantees of evaporation and temperatures are made. Contract test results generally exceed guarantees, but in practice we find that there is but a comparatively short time each year that refuse runs any way near these percentages; for instance, in winter we get a large percentage of ash while in summer we get a large per cent of garbage and vegetable matter with little or no ash. To offset lack of combustible matter in summer we store near the plant a large pile of ashes and mix as needed using a wheelbarrow load of ash to each charge of garbage.

The incinerator has satisfactorily handled the refuse of the city, making use of only two of the three units except during July and August. Its operation, as well as the collection of garbage and refuse, street cleaning and the removal of dead animals, which are taken to another plant and reduced to fertilizer, is under the sanitary department of the city of Atlanta of which John Jentzen is chief.



STEAM PRESSURE AND STEAM FLOW CHARTS, REFUSE INCINERATOR BOILER, ATLANTA, GA., FEB. 10, 1925

Principles of Refuse Incinerator Design

Principle 7 in the article entitled "Principles of Refuse Incinerator Design and Operation," published in our issue of Nov. 5, p. 764, giving the body of the report of the Committee on Refuse Collection and Disposal, Sanitary Engineering Section, A. P. H. A., was amended by the section before adoption. The original principle as printed in our issue named read "7. Each bidder should submit with his bid a list of two or more municipal plants operating successfully in the United States under conditions similar to those obtaining for the proposed plant and of the same pattern as the incinerator on which his bid is based." As amended, this section of the report reads: "7. If the bidder has constructed any plants similar to that proposed, he should submit with his bid a complete list of such plants. If he has not constructed similar plants, he should so state."

Letters to the Editor

This department aims to be a forum for the discussion of the views of engineers and contractors. The range of interest should be as wide as possible. Contributors are, therefore, asked to make their letters short.

Instrument for Recording Flow of Sewage

Sir—Experience of other cities in the use of instruments to record the flow in sewers would be of value to Pasadena just now. We have used copper tubing and a recording instrument operating under pressure, but this has not been found to be practicable and we feel that to install Venturi meters would be too expensive since we have 12 points on which it is desired to measure the flow in sewers in the cities of Pasadena, South Pasadena and Alhambra.

R. V. ORBISON,
City Manager (formerly City Engineer).

Pasadena, Calif.,
Nov. 13, 1925.

[Many devices for the purpose indicated are described in Metcalf & Eddy's "American Sewerage Practice," Vol. I, on design, but some of our readers may have used still other devices or they may have valuable information to report regarding their experiences with whatever recording devices they have had in use.—EDITOR.

Tile Drainage for Highways

Sir—During the years I spent in school and throughout several years experience as a drainage engineer and some years as an engineer connected with highway work, I have heard time after time, mostly stated as an introduction for a talk on highway construction, the following sentence: "The first principle of building a good road is adequate drainage."

No one questions the truth of this statement. Almost everyone connected with the construction of roads from the laborer up to and including the best authorities in highway construction preface their remarks with some such assertion and deep down in their hearts believe it.

But, universal as this belief is, how much real, practical, engineering ability is expended on this important "first principle?" In only a few instances have I seen this theory put into practice in the building of roads of different types, from the ordinary dirt road to the best types of surfaced highways costing thousands of dollars per mile.

In most cases, the drainage problems encountered in road building are considered only after all other problems have been solved. Usually this means that the drainage problems are slighted and not again considered until the time comes when relief is absolutely necessary. The cause of this condition may perhaps be a lack of technical knowledge on the subject of highway drainage; for nearly all articles and texts on road building are notoriously weak on information and instruction on that subject. It would seem that highway drainage is a problem for more serious consideration, and that publications devoted to the interests of good roads could well spare more space to the discussion of topics under this head.

One subject which has had too little serious consideration is the use of land tile for the drainage of the roadbed and right-of-way. In nearly all designs, typical sections of the roadbed show in detail the plan of the road ditches, but it is really hard to find a layout showing land tile laid at a level which is necessary in order to drain the roadbed properly. Why is this?

I have heard it stated that the cost of tile is prohibitive, but I believe any engineer who has gone to the trouble to figure the extra cost of using tile instead of open ditches, taking into consideration the cost of maintenance of the two types, will tell you that over a period of years the tile drainage is the cheaper. A point to consider here is the cost of this important "first principle," compared to the total cost of the road. Does it seem that an item of $5,000 is too much to spend in order to secure a good foundation for a $50,000 road? And yet that amount is probably several times the actual cost of a tile drainage system that would take care of the excess water much better than open ditches, the cost of maintenance of such a system over a period of years being practically nothing.

Again from a standpoint of safety, the tile-drained highway, with the proper cross-section, has a side road without deep ditches, over which it would be possible to drive. The backfilled tile ditch gives a cross-section on the side road over which a mower can be used, keeping down the growth of weeds, thus improving the appearance of the highway and also the vision of the driver on curves.

Too many of the deep open ditches have grown up to weeds, obstructing the flow of the water in the ditches. These open ditches owing to their design prohibit the use of a mowing machine and certainly increase the cost of maintenance to that extent.

I have no figures on the difference in the first cost of a road, due to the tile drained road requiring less excavation. But by platting the two cross-sections and figuring the difference in end areas, there is no doubt a respectable difference in favor of the tile.

I will not go so far as to say that tile could be used in all cases in preference to open ditches. The preference should be given to the type of drainage that fits each particular case. I do think, however, that the subject of tile drainage for highways deserves more study and consideration than it is now receiving.

In closing I would like to state that I have seen many instances in Iowa where the dirt roads were *made* by tile ditches, where before these roads were tiled it was impossible to keep them graded so that they were passable. You will find today, I venture to say, that more tile is used in road ditches in Iowa than in any other state, the reason being, I believe, because engineers in Iowa have been able to see the benefits of that practice.

I realize that I have only touched on the subject of tile drainage for highways. As I have said, I make no claim to be a highway engineer, but I do claim to understand the principles of drainage, and as I am a booster for tile drains for agricultural land, substituting tile for open ditches in every case where the practice is feasible, so do I believe that the same principles can be applied in the drainage of our highways, producing the same general benefits.

RALPH MCCORD,
Drainage Engineer of Department of Engineering, Huron County, Ohio.

Norwalk, Ohio,
Oct. 22, 1925.

Questionable Ethics of Employing Engineers

Sir—Most of the consulting engineers in the United States have, for years, been guilty of the practice of taking bids for the furnishing of professional services. The ones who are loudest in condemning the practice are most guilty of practicing it themselves. Of what use is it, for the American Society of Civil Engineers to send out circulars, and for you to write editorials against this practice, as long as they persist in keeping at it.

When these ethical and high-minded men need a helper of any rank or ability, they advertise, stating the general qualifications expected of the applicant and then tack on the phrase, "State lowest salary."

I fail to see why they should expect a man to indulge in unethical practices just because he is out of work or needs a better position. My own experience in hiring men has been broad enough to convince me that there is never any good reason why the salary should not always be stated in any ordinary help-wanted advertisement.

I wonder when we may expect to see the consulting engineers protest against *asking bids* as well as *bidding* for the furnishing of professional service.

J. GARDNER BENNETT,
Department of Civil Engineering,
Denison University.

Granville, Ohio,
Oct. 27, 1925.

News of the Week

CURRENT EVENTS IN THE CIVIL ENGINEERING AND CONTRACTING FIELDS

Surveys Started on Colorado River Aqueduct

Studies for Los Angeles Water Supply from Colorado River Well Under Way

Preliminary surveys and studies in connection with the proposed aqueduct for bringing Colorado River water to the city of Los Angeles are now under way, a $2,000,000 bond issue having been voted for this purpose at the last general election. An outline of the city's plans for bringing in Colorado River water appeared in *Engineering News-Record*, April 2, p. 560. H. A. Van Norman, assistant chief engineer and general manager of the Los Angeles bureau of water works and supply, states that plans are to be completed and estimates figured within the next year.

A résumé of progress, as outlined by Mr. Van Norman, follows: Preliminary triangulation and level control has been completed from White Water, approximately 22 miles east of Beaumont, southeasterly along the Indio Hills to a point northeast of Mecca and thence easterly across the Chuckawalla desert to Blythe. Along this route small-scale topographic sheets (1 in. to 5,000 ft.) have also been made. From these sheets and from the government topographic maps as well as from township plats of the U. S. Land Office a base topographic map has been made showing the country from the Colorado River to the city of Los Angeles over a belt or strip of territory extending from Needles on the north almost to the Mexican boundary on the south.

DETAIL MAPS

Preliminary traverse triangulation and large-scale detailed topography (one inch to 100 ft.) has been completed from the proposed point of diversion on the Colorado River to a point approximately 20 miles southerly and westerly toward Los Angeles. Detailed topography on a scale of 1 in. to 1,000 ft. with a contour interval of 20 ft. has been completed within certain limits of elevation from San Gabriel Canyon easterly along the base of the Sierra Madre Mountains to San Bernardino and thence southerly and easterly over San Gorgonio Pass to White Water. This work is being continued southeasterly and easterly from White Water along the Little San Bernardino Mountains, and just prior to Thanksgiving Day the survey parties were working near Shavers Summit in the Chuckawalla Valley. At that time equipment had been purchased and work was in progress on the construction of a road from Shavers Summit, Riverside County, to a point opposite Little Morongo Canyon, a distance of 50 or 60 miles. This road is to make accessible for further surveys very rough and difficult country in the Little San Bernardino Mountains in the vicinity of Indio. On the date mentioned this roadwork had been about one-half completed.

Engineering Fifty Years Ago

From *Engineering News*, December, 1875

The Proposed Hudson River Suspension Bridge

THE company organized some time ago under the name of the Hudson River Suspension Bridge and New England Railway Company, are again bringing to public notice the plan, long ago proposed, of spanning the Hudson River with a railway bridge. A board of engineers, appointed to consider and report upon the location, decided that the best point at which to span the river would be between Fort Clinton and Anthony's Nose. This point was chosen, and surveys have since been made for the various railroad connections which are proposed or decided upon. The plan of the bridge has also been perfected, and everything seems to be in readiness to proceed, so far as engineering preliminaries are concerned.—*Iron Age.*

West Side Changes at New York to Cost $27,000,000

Electrification and changes in grades on the West Side tracks of the New York Central R.R. at New York City, on the portion above 72nd St. will cost in the neighborhood of $27,000,000 according to a statement issued by the railroad company. The project has been approved by the state Public Service Commission, as noted in our issue of Nov. 19, 1925, p. 854. Grade separation on this portion of the West Side tracks was ordered earlier in the year.

Another Railroad Line in Florida

The Atlantic Coast Line Railroad Co. has applied to the Interstate Commerce Commission for authority to construct a line of railroad from Perry, in Taylor County, to Monticello, in Jefferson County, Fla., a total distance of 41 miles. The new line is to open up timber and agricultural country and to form a through line of the applicant's railroad from Florida to the West.

Large Outlay for Water at Boston Advised

$27,500,000 Proposed for Additional Supply at Worcester and at Boston

Additions to the Boston Metropolitan water-supply system and to the supply of Worcester, Mass., to be carried out immediately by a new construction commission provided with $27,500,000 for that purpose and for investigations related to further needs, are recommended by the Metropolitan Water Supply Investigation Commission in a report filed Dec. 1. Works for immediate construction include a $3,500,000 plant to treat some 26 m.g.d. of water from the existing South Sudbury system, which has been seldom used for some years past because its quality is not regarded as satisfactory; and $14,000,000 to provide a 45-m.g.d. supply by damming the Ware River near Barre Falls and diverting water from it into either some reservoir of the Worcester system or into the Wachusett reservoir of the Metropolitan system or both.

To still further increase the supply to meet the needs of the various communities until 1970, the commission estimates that developments on the Assabet and Ipswich Rivers and the raising of the Hobbs Brook dam of the Cambridge system, with pumping to the latter of flood flows from the lower Sudbury River, would provide 202 m.g.d. at a total cost of $53,500,000, the two last named totals including the projects noted in the preceding paragraph. A deep tunnel, under pressure, to supplement existing aqueducts leading to the Boston district, is estimated to cost $17,000,000. A more detailed summary of the report will be given in a later issue.

The commission, which was created in 1924, includes Charles R. Gow, consulting engineer, Boston, chairman; George F. Booth, Worcester; and E. E. Lockridge, engineer of the water-works of Springfield, Mass. Its secretary is Raymond C. Allen, an engineer of Manchester, Mass. As consulting engineer the commission engaged Allen Hazen, New York City, who, under authority of the commission, conferred frequently with Leonard Metcalf, of Metcalf & Eddy, consulting engineers, Boston.

Mobile Asking Bids for Piers of New Port Development

The Alabama State Dock Commission is asking for bids on pier No. 2 of the port development at Mobile. The estimated cost of the work is about $1,000,000. Work on pier No. 1 will be advertised as soon as certain dredging has been done for the service of existing facilities.

WASHINGTON NOTES

TWO reports, a majority and a minority report, have been submitted to the President by the Muscle Shoals Inquiry. The majority, consisting of the chairman John C. McKenzie, Senator Dial and R. F. Bower, state that the Muscle Shoals plant was built for the purpose of providing nitrogen compounds and not for power for distribution purposes. It favors devoting the whole development to the production of fertilizers under lease if a satisfactory one can be arranged. The minority, consisting of Harry A. Curtis and William McClellan, thinks that private leases are indispensable and favors separate power and fertilizer leases, the surplus power to be sold for distribution.

A BILL providing for the licensing of engineers in the District of Columbia, drafted by the commissioners, has been approved in principle by the Citizens Advisory Committee. The bill is to be introduced in Congress in the near future. It proposes the creation of a board of five engineers to pass upon the qualifications of those who apply for license.

One member of the committee objected to any such proposition characterizing it as "vicious, class legislation." He declared that during long residence in Washington he has known of no fraud involving an engineer.

The bill extends eligibility to Canadians which aroused objection on the ground that it was unfair to the nationals of other countries.

THE CORPS of Engineers is in a position to report promptly on the character of works necessary to halt the recession of the crest of the Niagara Falls, the Chief of Engineers states. It is General Taylor's conception that this work should be under the general direction of the Niagara Control Board. He will be glad to place the services of the district engineer at Buffalo at the disposal of that international body. So much study already has been given the problem that a formal survey would require only a short time.

Before anything can be done toward halting the recession an agreement must be ratified by Canada and the United States. After the agreement has been ratified Congress will have to authorize the survey and appropriate for it. It then will be necessary to secure additional legislation for the construction of the project itself. The slowness with which international affairs move and the delays incident to the securing of legislation are such that more than 25 ft. of additional recession is not unlikely, it is thought, before the erosion can be retarded. The recent airplane survey of the brink shows that 55 ft. of recession have taken place since 1917. The rate of erosion is increasing progressively as the water is forced more and more into the gorge it is wearing.

Hoover Asks Aid for Pure Science Research

Industrial Laboratories Depleting Ranks of Research Men Because of Lack of Funds

Secretary Hoover, speaking before the American Society of Mechanical Engineers at New York, Dec. 1, made a plea for financial aid for research work in pure science, work that is handicapped by a lack of sufficient funds to keep its workers from being drawn into the field of applied science. He said, in part:

"I wish on this occasion to say something upon our great national need of a much more vigorous support to pure science research in our country.

"There is no body of men more interested in the advancement of pure science than our engineers, for the engineering profession is built upon the application of scientific discovery.

"Research in the biological and physical sciences takes two forms: industrial research, (which is the application of science), and research in pure science. Obviously there must first be a pure science before there can be an application.

"Not only is our nation today greatly deficient in the number of men and equipment for this patient groping for the sources of fundamental truth and natural law, but the sudden growth of industrial laboratories has in itself endangered pure science research by drafting the personnel of pure science into their ranks—depleting at the same time not only our fundamental research staff, but also our university faculties, and thus to some degree drying the stream of creative men at the source. Thus applied science itself will dry up unless we maintain the sources of pure science. This is no complaint against our great industries and their fine vision of the application of science. It simply means we must strengthen the first line of our offensive.

"We have indeed some fine foundations for pure scientific research but the whole of the income available from these sources for research in pure science certainly does not exceed $10,000,000 a year—whereas in the professional schools of our universities, in technical and agricultural colleges, and experiment stations, in industrial laboratories and in our Government bureaus we probably expend today $200,000,000 a year upon applied science research.

"The problem as I see it is to secure much larger support—

First, to our university men, in order that they may be able to give a larger proportion of their time to research, and that our universities may increase the number of men.

Second, to co-ordinated research for certain definite purposes.

Third, to the pure science research institutions.

"It is on the men in independent research and in our educational institutions that the great burden of scientific advancement must always rest, and from them that the inspiration of the younger generation of oncoming scientific workers is derived. What we need above all things is the better support of these men. They should not, by the necessities of living and the cost of equipment, be forced into our industrial laboratories. Those men who show an aptitude for research should be less engulfed in teaching.

"Aside from direct support to these men there is another method of organization of research among these men that is no less in need of support. That is co-ordinated research in specific directions by men in different localities—again men mostly in our universities.

"We have prided ourselves on our practicality as a nation. Would it not be a practical thing to do to give adequate organized financial support to pure science? And if by chance we develop a little contribution to abstract learning and knowledge, our nation will be immensely greater for it."

Chicago Engineers Protest Delay in Pay Increase

About 300 engineers in the employ of the city of Chicago met recently to protest against the delay in granting them an increase in pay. Early in the summer engineers in the same service struck for part of a day to attract attention to their wants.

Wyoming Water Power Development Gets State Permit

The Seminole Power Co. has been granted a permit by the State of Wyoming to construct a hydro-electric power plant on the North Platte River, 40 miles north of Fort Steele, Wyo. The plans call for a dam 150 ft. high forming a reservoir with a capacity of 700,000 acre-ft. and a diversion tunnel 2 miles long.

Transportation Survey Finds No Demand for College Men

In a preliminary report the committee in charge of a nation-wide survey of transportation being made by Yale University finds that many railroad officials believe that college men make unpromising candidates for executive positions in transportation companies. College men are said to be too impatient of promotion and over-important in their own estimation. The committee raises the question as to whether the railroad officials are wrong in their opinions or whether the colleges are on the wrong track in their training of men for transportation service. It finds that the former do not make any attempt to select the cream of the graduating classes as do some of the other large companies. It finds also that courses in transportation in many colleges are stereotyped and unrelated to the actual business of transportation. Moreover, it finds that research in that field are surprisingly few and meagre outside the workshops of certain big companies. Where colleges do provide extensive courses in transportation the response of the students has been found to be disappointing.

Vancouver Plans for an Improved Water Supply

Ratepayers of the city of Vancouver, B. C., municipalities of Point Grey and South Vancouver, which form what is known as the Lower Mainland of British Columbia, have voted by an overwhelming majority for the formation of a metropolitan water board for the whole peninsula. The enabling bill to create the board has been prepared and will be presented to the present session of the Legislature, probably within the next two weeks.

The board will purchase the present Vancouver city watermain system for a sum of approximately $3,500,000, and the city will continue to operate its own distribution system. The board will be given power to spend up to $10,000,000 in capital construction for the development of the water supply, and extensive improvements on existing plants will be made.

The supply of water is found on the Seymour and Capilano mountains, and is brought across a wide arm of the Pacific ocean, known as Burrard Inlet, by means of submerged pipes. There are at present fifteen mains in this work. The board will be required to consider the advisability of constructing a tunnel to carry the pipes, in view of the tremendous risk at present, owing to dragging anchors of ships riding in the Inlet.

During the past few years the water supply on the higher levels of the city has been scarce in summer.

Movable Bridge at the Soo Damaged in Collision

Western Arm Struck by Ship—Whole Arm Displaced Three Feet—Rapid Repair Work

The western arm of the American swing bridge, one of the two movable bridges over the canal on the American side at Sault Ste. Marie, Mich., was struck at 2:30 a. m., Oct. 18, by the S. S. Crosby, upbound, at a point in the fifth panel from the end. The bridge is a single track drum-bearing through swing span, 398 ft. long, built in 1888, with its center pier on an island in the old American canal. The impact of the collision put a kink of about 2 ft. in the lower chord and crippled the two lower chord sections in the panel next to the loading girders over the circular drum and displaced the western arm bodily in a northerly direction, a distance of about 3 ft.

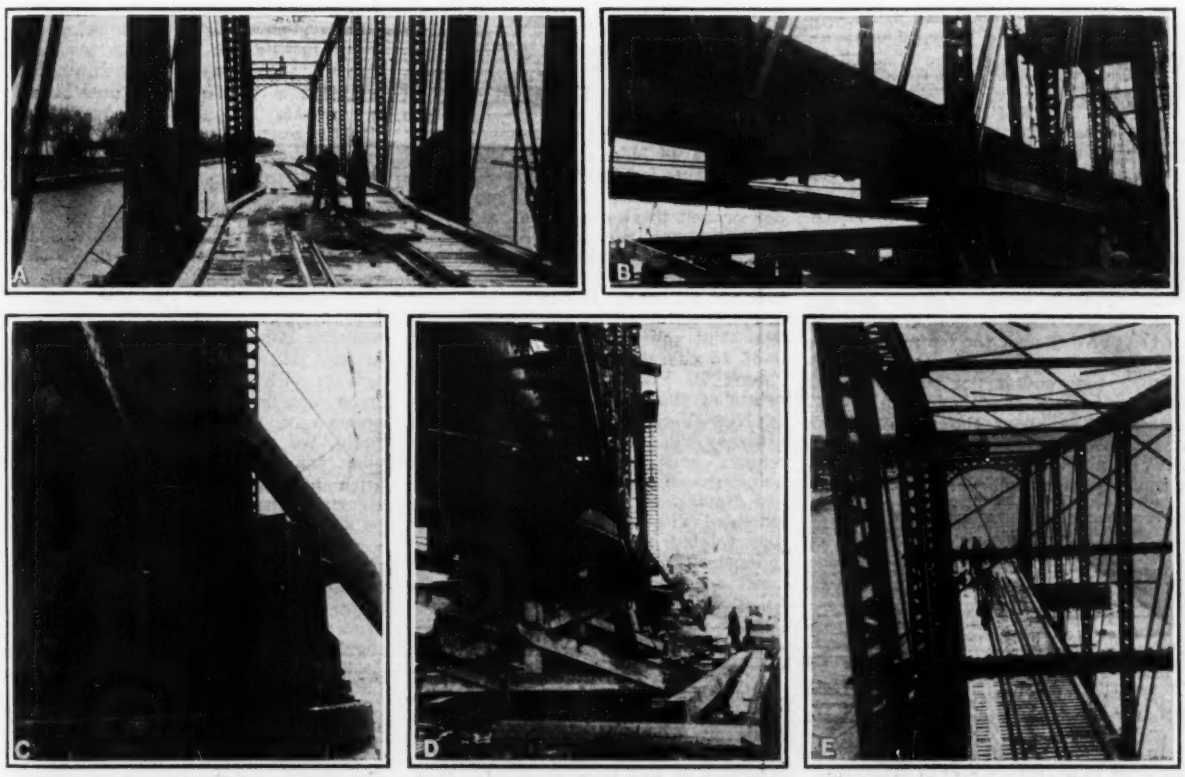
The end locks had not been withdrawn before the steamer struck the bridge, but the collision swung the bridge into open position and by the time it reached the rest piers its damaged end had sagged down sufficiently to allow it to foul the top of the north rest pier. While in this position it was blocked up to arrest further subsidence. Railway traffic was completely tied up by the accident, but there was no detention to canal traffic.

When daylight came the damaged arm was jacked up and moved on to its rest pier and work was started on removing the three damaged bottom chord sections, a portion of the damaged post P-4, immediately west of the point of impact as well as several laterals and other minor damaged details of the structure. The new parts required were ordered on the 19th and arrived at the bridge on the 22nd. In the meantime, the damaged portions of the operating machinery were overhauled and renewed by local mechanics and the railway bridge and building department.

The new material was transported across the busy waters of the canal and was completely bolted in place ready for the passage of the first train during the forenoon of Oct. 24, the sixth day after the accident. In this time three heavy bottom chord sections 27 ft. long, one 27-ft. post, three 5-in. chord pins about 2 ft. long, together with sundry plates and angles, were fabricated, transported 622 miles and incorporated in the structure.

Riveting was done after the bridge had been restored to normal operation. Further reinforcements or renewals will be undertaken after navigation closes. At that time the bridge can be kept in the closed position, blocked on falsework if necessary, and the repairs can be made without delay to canal or railway traffic.

The work was carried on by the bridge and building departments of the Canadian Pacific and the Duluth, South Shore and Atlantic Railways, and the Dominion Bridge Co.



SWING BRIDGE AT SAULT STE. MARIE DAMAGED IN COLLISION

(A) Western arm showing floor offset 2 ft.; (B) point of impact; (C) panel 7 in. crippled south truss; similar damage occurred in north truss; (D) another view of point of impact; (E) broken top laterals and general curve in alignment.

Propose Three Movable Span Bridges Within Two Miles

The highway department of the state of Washington is making a relocation of the 10.6-mile stretch of Pacific Highway between Everett and Marysville, Wash., whereby the distance will be shortened 5 miles and in which three movable span bridges are being constructed with a 2-mile length of the highway. The project was undertaken because the present route includes dangerous curves and has a long trestle and a bridge that would soon require complete renewal.

The present road between the two cities skirts the low delta mouth of the Snohomish River passing over two moveable bridges and one-half mile of trestle. Part of this road is below high water level and is submerged from 1 to 5 ft. each year for periods varying from a day or two to two weeks. During this period the traffic over the Pacific Highway must either wait or make a very long detour. The summer traffic averages about 4,000 cars per day and winter traffic about 2,000 cars per day. On special holidays traffic as high as 15,000 cars is not unusual. The present route is very poorly located, has many dangerous curves, the pavement is in a bad state of repair and the trestle and one of the bridges will require renewal in a short time.

The new location follows a straight line across the delta mouth of the Snohomish River, carrying the roadway chiefly on bridges. The economics of the situation have been summed up as follows:

Cost of bringing present highway up to standard:	
8 miles of new location and pavement..	$480,000
½ mile of permanent standard trestle..	300,000
½ new movable span.....	125,000
	$825,000
Cost of constructing proposed cutoff on new location:	
Bridges.....	$1,050,000
Grading and pavement (3 miles).....	275,000
	$1,325,000

Comparative costs of motor car operation, figured on a normal average yearly traffic of 2,500 cars per day and at 8c. per mile, would be $2,120 per day over the 10.6 miles of the old route and $1,120 per day over the 5.6 miles of the proposed new route. The cost of maintaining the road is not considered, as the maintenance of either route is estimated to be about the same, with a slight advantage for the cutoff. Figured on a long-term basis the comparative costs are as follows:

Construction:	
Present route.....	$825,000
Cutoff.....	1,325,000
Difference.....	$500,000
Interest (5 per cent of difference).....	25,000
Cost of operation to the motorist:	
Present route.....	$775,000
Cutoff.....	410,000
Difference.....	$365,000
Interest (5 per cent of construction cost difference).....	25,000
Net difference in yearly cost.....	$340,000

In other words, if the saving to the motorist in operating cost is considered, the entire cost of building the cutoff would be paid off by the net saving in a little less than four years.

Plans for the new cutoff were prepared by Chas. E. Andrew, bridge engineer, Washington state highway department, from whom the foregoing information has been obtained. J. A. McEachern & Co., Seattle, Wash., hold the contract which was awarded on a bid of $972,000.

14 Inches of Rain Fall at Miami, Fla.

A rainfall amounting to a total of 14.1 in. is reported to have occurred at Miami, Fla., beginning Sunday evening, Nov. 29, and ending the following noon. The previous record fall had been 9.76 in.

Engineers Selected for Bridge Over Mississippi River

The Public Belt Railroad Commission at New Orleans has announced that the engineering firm of Ralph Modjeski, of New York, has been selected to design and supervise the construction of the $15,000,000 bridge over the Mississippi River at New Orleans. Borings at the site of the bridge are to start this month.

Union Pacific Ry. to Double-Track 25 Miles in Utah

Plans of the Union Pacific Railroad for double-tracking its main line in the neighborhood of Devil's Slide in Utah have been completed and the company has called for bids on the work which is estimated to cost in the neighborhood of $2,600,000, or an average of $100,000 per mile. The high cost of the work is due to the fact that a large part of the excavation will be in rock. One tunnel 840 ft. long and several bridges are included in the work.

Metcalf & Eddy Income Tax Appeal Heard Nov. 30

The appeal of Metcalf & Eddy, consulting engineers, from an adverse decision of the Federal district court in Massachusetts in a case involving the right of the Federal government to tax fees received from state and municipal governments was argued Nov. 30 before the United States Supreme Court. Under protest these engineers paid $1,259 to the internal revenue collector as excess profits from their partnership in 1917, claiming that there is no constitutional authority to tax income from a state or other political subdivision. The trial court granted exemption in 2 of 20 cases at issue. In behalf of Emma B. Brunner, executrix of the estate of the late Arnold W. Brunner, of New York City, Lewis M. Isaacs, attorney, filed a brief in the case as *amicus curiæ*, arguing on behalf of the points raised by the attorneys for Leonard Metcalf & Harrison P. Eddy. An extended editorial discussion of this case and related matters, with references to earlier articles in our columns giving court decisions and the opinion of the solicitor general of internal revenue appeared in *Engineering News-Record*, Aug. 13, p. 251.

Random Lines

Fair Enough

One of the engineers for the new water supply of Athens, writes R. H. Keays, who has gone over there as chief engineer of that work, had to make a report to the Greek Government on a pumping station and in this report, which was written in English, he stated at one place that everything "would be made ship-shape." The translator got this in the Greek "Everything in the pumping station will be made in the shape of a ship."

* * *

Scrambled Speech

What we may come to if a universal language can be put over is illustrated by the report of a meeting of the Western Society of Engineers, at which E. F. McPike lectured on "Ido," as a proposed international language. The report given in the *Journal* of the society is as follows:

Vespere, 19-a Oktobro, 1925, koram la Westala Societo di Injeniori, Chicago, Eugene F. Mc-Pike, diskuris en Ido ed Angla, pri la problemo di linguo internaciona por mondo-komunikado. Il montris tridekatri lumprojekturi en Ido ed explikis kelka detali di la linguo. Pro la rapida developo di radio, ni probable havos komuna linguo ante multa yari. Tala linguo devas esar konstruktita ciencale. On ne povus adoptar, por internaciona relati, ula naturala linguo, exemple Angla o Franca, nam to donus tro grand avantajo a la populo di qua ol esas la matrala linguo. Ni devos havar neutra linguo, quale, Ido, qua esas reguloza, preciza, klara, fonetikala ed eufona.

TRANSLATION

On the evening of the 19th of October, 1925, before the Western Society of Engineers, Chicago, Eugene F. McPike discoursed in Ido and English, concerning the problem of an international language for world-communication. He showed thirty-three stereopticon slides in Ido and explained some details of the language. On account of the rapid development of radio, we probably will have a common language before many years. Such a language ought to be constructed scientifically. One would not be able to adopt any natural language, for example, English or French, for that would give too great an advantage to the people of whom it was (is) the mother-tongue. We ought to have a neutral language, such as Ido, which is regular, precise, clear, phonetic and euphonious.

* * *

A Couple More Engineers

(169) *Analyzation Engineer*—E. J. Shassberger, of the Olds Motor Works.

(170) *Mattress Engineers*—Schultz & Hirsch Co., pioneers in mattress engineering for almost fifty years.

Engineering Societies

Calendar

Annual Meetings

HIGHWAY RESEARCH BOARD, NATIONAL RESEARCH COUNCIL, Washington, D. C., Annual Meeting of the Highway Research Board, Washington, D. C., Dec. 3-4, 1925.

AMERICAN ROAD BUILDERS ASSOCIATION, New York City; Annual Convention, Chicago, Ill., Jan. 11-15, 1926.

AMERICAN ENGINEERING COUNCIL, Washington, D. C.; Annual Meeting, Washington, D. C., Jan. 14-15, 1926.

ASSOCIATED GENERAL CONTRACTORS OF AMERICA, Washington, D. C.; Annual Meeting, Portland, Ore., Jan. 18-23, 1926.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City; Annual Meeting, New York City, Jan. 20-22, 1926.

ENGINEERING INSTITUTE OF CANADA, Montreal; Annual Meeting, Toronto, Ont., Jan. 27-29, 1926.

AMERICAN CONCRETE INSTITUTE, Detroit, Mich.; Annual Meeting, Chicago, Ill., Feb. 23-26, 1926.

The Texas Section of the Southwest Water Works Association will hold its eighth annual short school for water plant operators at Fort Worth, Texas, the week beginning January 18, 1926.

The Illinois Association of Highway and Municipal Contractors will meet Dec. 16 and 17 at the LaSalle Hotel, Chicago. Frank T. Sheets, chief highway engineer, Illinois, will speak on problems in carrying out the Illinois program. S. M. Williams, vice-president, Autocar Co. and chairman of the committee on uniform questionnaires appointed by the Joint Conference on Construction Practices, is scheduled to talk on "Establishing Responsibility in Construction." M. R. Hunter, president, Associated Equipment Distributors, will speak on "Effects on New Contractors of Giving Long-Term Credit on Equipment." Highway specifications and field operation, cost accounting, job estimating and freight traffic are other subjects scheduled. J. F. Gallagher, 133 W. Washington St., Chicago, is the executive secretary.

Personal Notes

CAPT. JOEL I. CONNOLLY, district engineer in charge of Interstate Sanitary District 3, Chicago, of the U. S. Public Health Service, has been appointed chief of the Bureau of Sanitary Engineering, Chicago Department of Health. In 1919 and 1920 he was chief sanitary engineer for the Near East Relief Expedition in Asia Minor and still is retained as a lecturer on the Near East Relief. Capt. Connolly started his sanitary work with the Massachusetts State Board of Health in 1917 following postgraduate work at Harvard and Massachusetts Institute of Technology. The Bureau of Sanitary Engineering is a recent collecting together of six related divisions of the Health Department as follows: Plumbing and building; ventilation; water safety control; smoke control; industrial sanitation; community sanitation.

WILLIAM L. ABBOTT, chief operating engineer of the Commonwealth Edison Co. of Chicago, has been elected president of the American Society of Mechanical Engineers.

DR. OSKAR VON MILLER, president of the German Engineering Society, was the guest of honor at a dinner given by the Merchants Association of New York and the trustees of the Museum of Peaceful Arts at New York on Nov. 24. Dr. von Miller is taking an active interest in the proposal to establish museums of the industrial arts in this country.

JOHN A. BREMER, who for the past five years has been chief engineer of the Walker River Irrigation District, Yerington, Nevada, has been appointed chief engineer of the Montague Irrigation District with headquarters at Montague, Calif.; the district voted $1,395,000 in November for the construction of an irrigation system.

JOHN P. H. PERRY, a vice-president of the Turner Construction Co., New York City, has gone to Florida for the winter to take care of the company's interests there. He is to be at the company's office, 1445 N. E. Bay Shore Drive, Miami.

C. C. COTTRELL, recently chief engineer of the Western Willite Co., San Francisco, Calif., severed his connection with the company Dec. 1 to become president of the Cottrell Engineering Corporation and consulting engineer of the California State Automobile Association.

RAYMOND WARD and ROLFE F. FARSTAD have joined the organization of Gannett, Seelye & Fleming, Engineers, Inc., of Harrisburg, Pa. Mr. Ward as a member of the organization is working for the American Utilities Co.; he is a graduate of Pratt Institute and was formerly with the Chile Exploration Co. at Chuquicamata, Chile. Mr. Farstad is in the valuation department and is working in Louisiana. He is a graduate of Ohio Northern University.

JOHN H. CATON, former director general of public works for the government of Santo Domingo, has joined R. W. Hebard & Co., Inc., engineers and contractors, New York City, and will assume the position of assistant chief engineer of their government highway contract in Salvador, Central America.

SCOTT MITCHELL, city manager of Boulder, Colo., has resigned. The position was offered to GEORGE W. TEAL, a local mining man, but he refused and the position is now vacant.

MAURICE W. WILLIAMS, vice-president of the Technical Advisory Corporation, New York City, has been engaged as engineer by the Barge Canal Survey Commission, a special commission of the state of New York charged with making a study and survey of the operation and facilities of the barge canal and reporting to the legislature on Feb. 15 next.

FRED S. ALDEN, former assistant city engineer of Cedar Rapids, Iowa, has been appointed city engineer to fill out the unexpired term of T. F. MCCAULEY, who has resigned. Mr. Alden has done railway location and grade reduction for the Illinois Central R. R., street railway construction in Mason City, Iowa, dam and canal construction work for the Great Northern Power Co. in Minnesota, and sewer construction in Paducah, Ky. Just prior to going to Cedar Rapids he was in charge of the first ten miles of the Pierre-Rapid City extension of the Chicago & Northwestern Ry.

FRANK P. MCKIBBEN, Professor of Civil Engineering at Union College, Schenectady, N. Y. and city engineer of Schenectady, has resigned from both positions to devote his time exclusively to his engineering practice. His resignation from the college takes effect in June next and from the city office on January 1 next.

Obituary

EDLOW W. HARRISON, consulting engineer, Montclair, N. J., at one time chief engineer of the Passaic Valley Sewerage Commission, died Nov. 27, of heart disease, at his home in Montclair, aged 74 years. Mr. Harrison was born in New York City and studied engineering at Cooper Union College. His early work was for the New Jersey riparian board and as assistant engineer of the Jersey City water department; and he was engineer of the Jersey City Water Supply Co. which built the dam and aqueduct for the Boonton, N. J., water supply. Then he was chief engineer in laying out the Hudson Boulevard in Hudson County, New Jersey. Relative to the Passaic Valley trunk sewer, he first served on the sanitary and navigation problems and later was chief engineer of the Passaic Valley Sewerage Commission in preparation of construction plans, up to 1911. For some years following 1883 he had been connected with state valuation of railroads in New Jersey, establishing methods and bases for taxation of the railroads in the state.

GEORGE HENRY LOWRANCE, of Lowrance Bros. & Co., Memphis, Tenn., prominent in levee construction, was drowned Nov. 13 at Hollybrook, Miss., where he owned and operated a farm.

From the Manufacturer's Point of View

A Point of Contact Between Maker and User of Construction Equipment and Materials

Southern Pine Sales Group's Co-operation Plan

Customers Given Advance Notice and Details of Manufacturer's Sales Meeting

AN EXAMPLE of industrial co-operation in which the customer is advised of the merchandiser's responsibilities and sales plans is seen in connection with the recent meeting of the mill representatives and salesmen of the Southern Pine Sales Corporation.

About two weeks prior to the meeting a circular letter was sent out addressed to "Our Customers, Actual and Prospective." In addition to the letter to create a "completeness of understanding," a program of the coming meeting was included. Going somewhat further than is customary, each subject to be considered at the meeting was divided into a number of sub-heads giving the main points to be covered. The detail in which this was done is illustrated by the talk on "Grading of Lumber" which was sub-divided as follows:

(a) Suggested changes in present grades and grading rules

(b) Special grades

(c) Education of mill inspectors

(d) What should be considered a fair mark of perfection for the total annual amount of a mill's shipment

(e) Re-inspection when complaints are made; what latitude should be allowed salesmen in making settlements without incurring the expense and inconvenience of official inspection

(f) To what degree are salesmen responsible for complaints and how can there be improvement?

As may be seen this and sub-head outlines of the other speeches gave the customer, in this case the retailer, an insight into methods that were being used or contemplated to "sell" him. He may thus be made to realize that his interests are being fairly considered and his co-operation should thus be more easily secured.

Business Notes

INTERLOCKING TILE CORP., Cleveland, Ohio, announces the opening of two new offices on the Pacific Coast; one in Los Angeles, with George H. Rogers as district sales manager, and the other in San Francisco, with J. S. DeSilva, district sales manager.

CELITE PRODUCTS CO., Los Angeles, Calif., announces the appointment of James Reed as works manager in charge of the plant operations of the company at Lompoc and White Hills, Calif.

MIAMI CRUSHED ROCK CORP., Miami, Fla., has recently been organized and has purchased a considerable acreage in the Dade County rock district at Kendall, Fla. Plans are to erect a rock crushing and screening plant with 1,000 yd. per day capacity. The object of the corporation is to quarry coral rock, crush, wash and screen. Edwin C. Moore, of Coral Gables, Fla., is president and general manager.

THE DORR CO., engineers, 247 Park Ave., New York City, announces the appointment of E. L. Bateman, the Corner House, Johannesburg, as sole agent for their equipment in South Africa.

B. R. BATES, of the Dorr Co., New York City, has returned to New York from South Africa, where he has been for the past few months on business connected with the company's interests in that country.

ALLIS-CHALMERS MFG. CO., Milwaukee, Wis., has opened a new district office in Lima, Peru, in charge of W. G. Bolton. The company's office at Oruro, Bolivia, is in charge of P. G. Gilliard, succeeding Erling Winsnes, who has returned to the United States.

J. C. HAGGART, JR., has been elected vice-president of the Republic Motor Truck Co., Inc., Alma, Mich. Mr. Haggart has been associated with the Republic Truck Co. for the past nine years, both as chief engineer and assistant to the president.

GILMAN MFG. CO., East Boston, Mass., manufacturers of rock drills, has appointed the Hubbard-Floyd Co., Inc., 452 Lexington Ave., New York City, as its agent in the metropolitan district.

CLYDE IRON WORKS, Duluth, Minn., announces the appointment of the Beckwith Machinery Co., Pittsburgh, Pa., with branch offices at Philadelphia, Cleveland, and Charleston, W. Va., as a new distributor for its equipment in the territory adjacent to these cities.

MILWAUKEE ELECTRIC CRANE & MFG. CO., INC., which was a New York corporation during business at Milwaukee, has been reorganized under the laws of the state of Wisconsin as the Milwaukee Electric Crane & Mfg. Corp.

C. L. WOOD, formerly assistant general manager of sales, Carnegie Steel Co., Pittsburgh, Pa., has been appointed general manager of sales to succeed William G. Clyde, recently elected president of the company.

CLYDE L. JONES has accepted a position with the Reading Iron Co., Reading, Pa., in its sales department in the St. Louis territory; his headquarters will be in the Railway Exchange Building, St. Louis.

JOSIAH FRANCIS JOHNSON, manager, general engineering division, South Philadelphia Works of the Westinghouse Electric & Mfg. Co., died very suddenly on Nov. 12. Mr. Johnson was born July 15, 1879, graduated from Pennsylvania State College in 1905 and entered the employ of the Westinghouse company at that time.

Equipment and Materials

New Feature Designed to Reduce Wear on Clamshell Bearings

Since the second sheave in a block-and-tackle reeving moves at about one-half the speed of the first sheave, the Blaw-Knox Co., Pittsburgh, Pa., has taken advantage of this fact to reduce the bearing speeds on its Dreadnaught clamshell bucket by about one-half. The new design furthermore doubles the bearing areas.

Rope guards
Three grease gun connections in this sheave for convenience in greasing
Cup bushing in lever arm
Grease gun connection
Sheave "B" turns on pin Closing line leads in on this sheave
Plows for cleaning sheave grooves when working in sticky clay
Hardened steel pin turned by sheave A
Key
Sheave "A"

Referring to the illustration, sheave A turns at about one-half the speed of sheave B. Instead of turning the sheave on a short fixed pin, as is the usual practice, the pin itself is revolved at one-half the speed of the closing line by keying it to sheave A. Sheave B, with its extra long bearing, obtained by offsetting the hub of sheave A, turns, of course, at full line speed but it turns on a surface moving at one-half speed in the same direction. The bearing speed is, therefore, one-half, arrived at by the difference between the full speed of sheave B and the half speed of the pin. This new arrangement is claimed by the company to increase the life of bearings and sheaves in clamshell buckets from 10 to 20 times over the old method of using a fixed pin.

The vulnerable point in a lever arm bucket has always been these sheaves and bearings at the end of the lever arm. They must be fully protected against the entry of sand and other

materials which destroy the bearings and bushings. The outside ends of the bearings have no openings and oozing of the grease at the inside as the pin moves slightly, similar to a piston in a cylinder, seals the bearings effectively. The large cup bushings effectively prevent wobbling of the sheaves with resultant flange wear. Wherever motion occurs a bushing is provided and a high pressure Alemite gun is used to force grease into the bearing.

Power Shovel Construction Uses 100 Standard Ford Parts

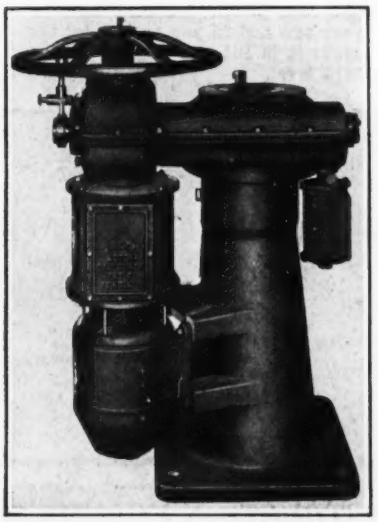
The new ¾-yd. shovel manufactured by the Wilford Power Shovel Co., Detroit, Mich., is operated by a standard Fordson tractor power plant and contains in its construction 100 Ford touring car, truck and tractor parts exclusive of those used in the tractor. The machine requires but one man to operate and is claimed to handle ¾ yd. five times a minute. The makers say that there were two outstanding reasons that prompted the building of this portable shovel. First, it is designed for those contractors whose work does not warrant the purchase of a large steam shovel, and, second, on the larger operations, to give efficient service where high mobility is needed. The machine can also be used as a crane with a lifting capacity of 4,000 lb. Lubrication is by the Alemite high-pressure system and the weight of the equipment complete with the tractor is 4½ tons.

The dipper is of plate construction with four manganese teeth; it is attached to an 8-ft. dipper handle constructed of two 5-in. channels. The 13-ft. boom of two 6-in. members is raised and lowered by a worm and worm gear. The swing circle consists of one electric steel casting on which all machinery bearings are cast integral. It will swing three-quarters of a complete circle before being stopped by automatic spring bumpers. There are no shipper shaft pinions, gears or brakes and the usual dipper handle racking is also eliminated, a single cable operating the dipper handle up or down. Hoist, crowd and swing are operated by three hand levers and one foot pedal operates complete digging control. The machine has a dumping range of 11-ft. height and 14-ft. radius.

Motor Unit Completely Closes Valve Before Motor Stops

A new valve operating mechanism known as the Kelty motor drive completely closes the valve before the motor stops, thus eliminating the usual necessity of making the final tightening closure by hand. This motor drive is manufactured by the Coffin Valve Co., Neponset, Mass., which company claims that its action has not been previously available in the electrical operation of valves.

After the valve is closed, the motor is stopped by the action of a multiple disk friction clutch which is used instead of a limit switch for this purpose. Should an obstruction be caught in the valve during its closure, the motor stops as though the valve were closed without damage to valve parts or motor. The friction clutch is thrown out of operation when the valve is being opened so that full power of the motor is available.



Publications from the Construction Industry

Sewage Disposal — EASTERN CLAY PRODUCTS ASSOCIATION, Philadelphia, Pa., has made available a small booklet describing methods of sewage disposal for farms and suburban homes. Diagrams and text portray several typical installations making use of vitrified clay pipe and septic tanks.

Electrical Supplies — McGRAW-HILL Co. has purchased the EMF Electrical Year Book published by Electrical Trade Publishing Co., Monadnock Block, Chicago. The 1926 edition, which will be out April 1, 1926, will be edited by the staff of the Electrical Trade Publishing Co. and sold by the staffs of both organizations. Headquarters for the Year Book until completion of the 1926 edition will be at the offices of the Electrical Trade Publishing Co. in Chicago, but information and data may be secured from men of both organizations. This standard reference book will supplement the service of McGraw-Hill electrical publications by supplying the reference information needed by buyers and specifiers throughout the industry.

Snow Removal Practice. — GOOD ROADS MACHINERY COMPANY, INC., Kennett Square, Pa., has made available a hand book on snow removal practice for the benefit of road officials and others who may be interested in the best methods of snow removal. The booklet is divided into a number of sections, the more important of which include a snowfall table by states, a description of the different methods of fighting snow difficulties, the mechanics of snow removal with snowplows. The remainder of the booklet is devoted to descriptions of the organizations required in a state and city for snow removal, discussed separately from the point of view of each political unit and set of interested persons.

Gas and Electric Welding—CHICAGO STEEL & WIRE CO., Chicago, manufacturers of Weldite welding rods, has published a very useful booklet on the properties of steel filler rods for gas and electric welding. The booklet describes the method of manufacturing filler rods, the manufacturing differences between the filler rods for gas and electric welding, causes of weld failures, general significance of chemical analysis, effect of analysis on both gas and electric filler rods, flux coatings, and cast-iron and alloy steel filler rods. The last two pages of the booklet are devoted to analytical details of different types and sizes of Weldite. It is planned to issue a second treatise of this same nature on the "Use of Standardized Filler Rods."

Electric Motors — ALLIS-CHALMERS MANUFACTURING CO., Milwaukee, Wis., has recently issued bulletin No. 1132, describing its polyphase induction motors, using cast-steel frames and Timken tapered roller bearings.

Modern City Garage Construction—RAMP BUILDINGS CORP., 21 East 40th St., New York, N. Y., has issued catalog 25, devoted to the building of multi-floor garages for storage efficiency and operating economy. The booklet has been prepared for distribution to engineers who are interested in the construction of modern garages. It has been prepared to demonstrate the profits which are returned from the investment in a building of efficient design, as well as to briefly describe and illustrate the d'Humy Motoramp system of inter-floor travel. There are illustrations of typical installations and a list of garages which utilize this space saving plan, which show the extent to which this patented design has been used throughout the country.

Engineering News-Record Statistics of the Construction Industry

December 3, 1925 — *in the United States* — Vol. 95, No. 23

Engineering News-Record CONSTRUCTION COST Index Number (1913 = 100)

MONTHLY
January, 1924, to Date

December, 1925	205.95
November, 1925	205.95
December, 1924	208.58
Peak, June, 1920	273.80
1913	100.00

1924

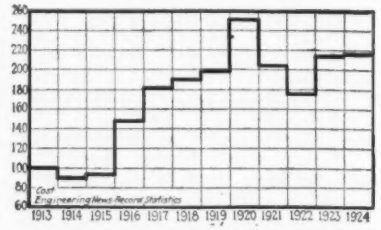
Jan.	217.90	May	222.38	Sept.	211.25
Feb.	220.30	June	216.85	Oct.	207.55
March	224.60	July	214.40	Nov.	205.70
April	221.60	August	213.15	Dec.	208.58

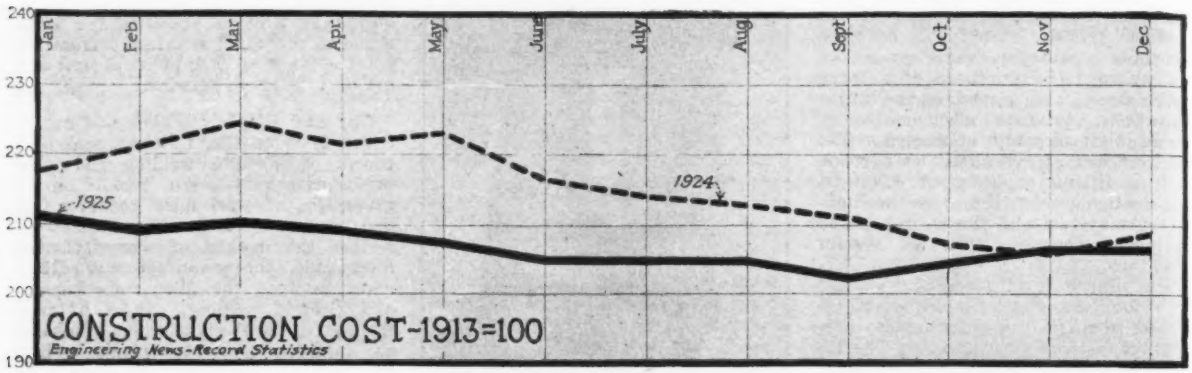
1925

Jan.	210.40	June	204.60
Feb.	209.70	July	204.60
March	210.20	August	205.60
April	209.55	Sept.	202.10
May	207.20	Oct.	205.35

ENGINEERING NEWS-RECORD'S Construction Cost Index Number is unchanged from the November level. There is notable lack of price fluctuation despite record volume for this time of the year. The average rate for common laborers is still 54c. per hr. for the entire country as against 53c. three months ago and 56¼c. one year ago. Thus general construction cost is one per cent below a year ago and 25 per cent under the peak; it is 105 per cent above the 1913 level.

YEARLY
1913 to 1924





Engineering News-Record CONSTRUCTION VOLUME Index Number (1913 = 100)

MONTHLY
January, 1924, to November, 1925

November, 1925	194
October, 1925	233
November, 1924	128
Peak, August, 1925	266
1913	100

1924

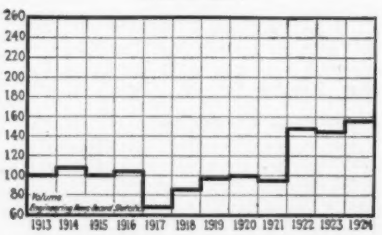
January	125	May	194	September	159
February	144	June	149	October	164
March	161	July	161	November	128
April	159	August	162	December	145

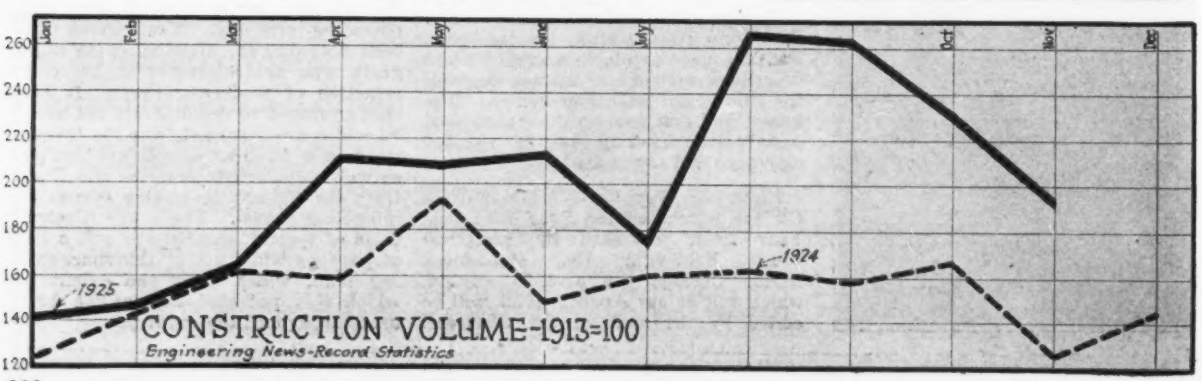
1925

January	141	May	209
February	145	June	214
March	161	July	178
April	211	August	266
September	262		

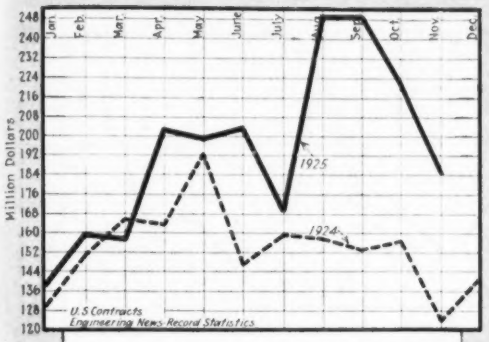
ENGINEERING NEWS-RECORD'S Construction Volume Index Number is 194 for the month of November, and 154 for the whole of 1924, as against 100 for 1913. This means that the actual volume of construction in 1924 (not the mere money-value of the contracts let that year) is 54 per cent above the volume of construction for 1913. The monthly volume number, 194 for November, 1925, contains the increment of construction and indicates the rate at which contracts are being let as compared with 1913 awards.

YEARLY
1913 to 1924

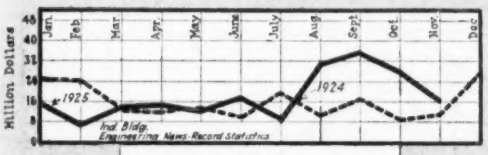




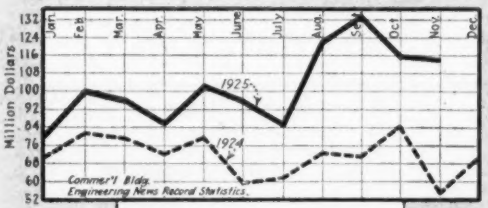
Monthly Statistics of the Construction Industry



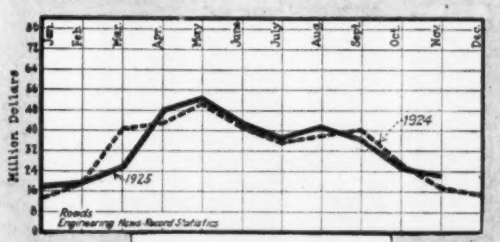
Contracts Awarded in the United States
Reported in E. N.-R.



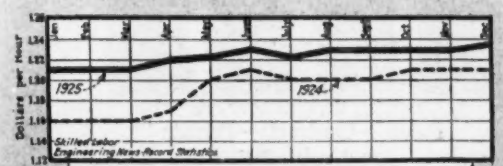
Industrial Building Awards
$40,000 and Over



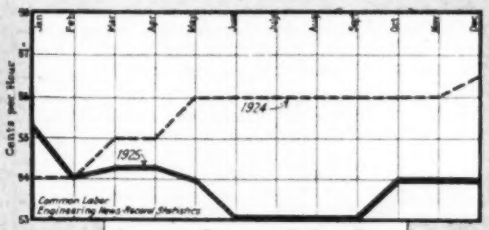
Commercial Building Awards
$150,000 and Over



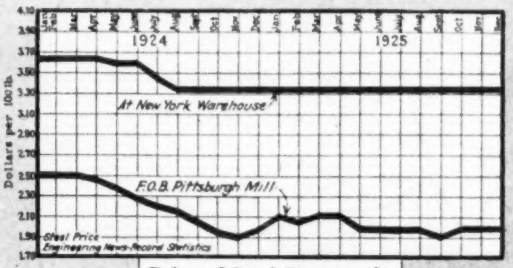
Street and Road Lettings
$25,000 and Over



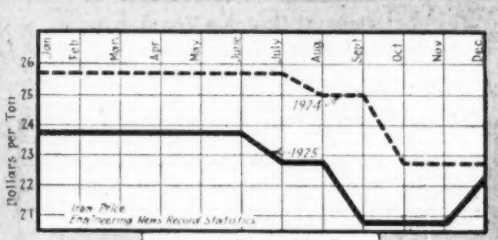
Average Wage of Skilled Building Trades
Bricklayers, Carpenters and Steel Erectors



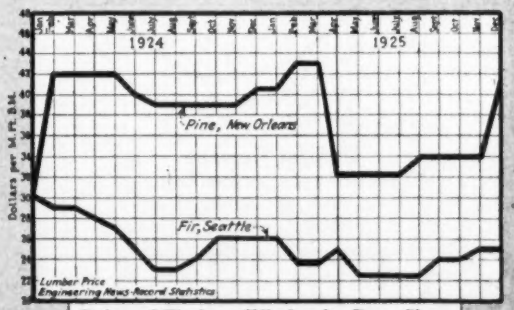
Average Common Labor Rate
Pick and Shovel Men


Dollars per 100 lb.
Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec. Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.
1924
1925
At New York Warehouse
F.O.B. Pittsburgh Mill
Steel Price
Engineering News-Record Statistics

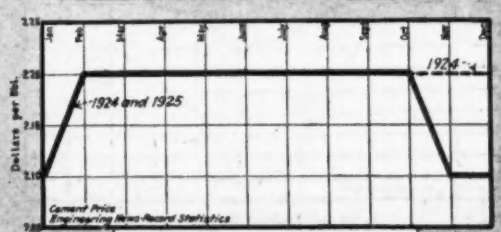
Price of Steel Structurals
Shapes 3-In.; Plates ¼-In.



Price of Basic Pig Iron
F.o.b. Pittsburgh

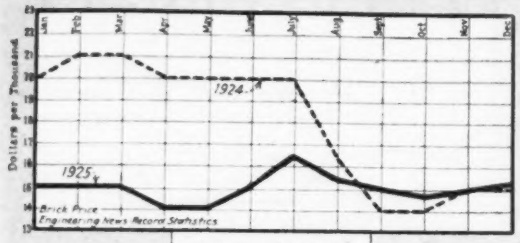

Dollars per M Ft. B.M.
Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec. Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.
1924
1925
Pine, New Orleans
Fir, Seattle
Lumber Price
Engineering News-Record Statistics

Price of Timbers, Wholesale, Base Sizes
Car Lots to Contractors

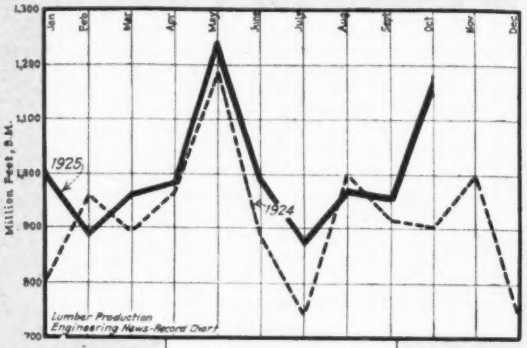

Dollars per Bbl.
Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.
1924
1924 and 1925
Cement Price
Engineering News-Record Statistics

Net Price of Portland Cement
Car Lots, F.o.b. Chicago

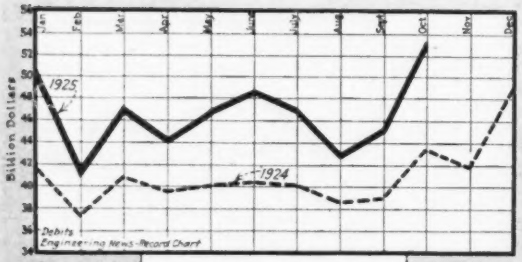
Monthly Statistics of the Construction Industry



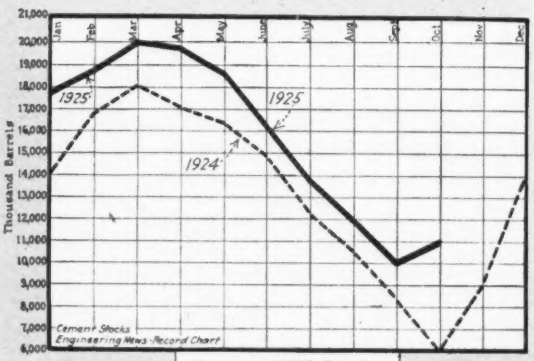
Price of Brick
At Dock, New York



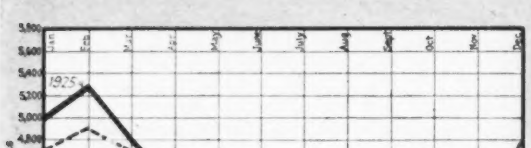
Lumber Output
Nat. Lumber Mfrs. Assn.



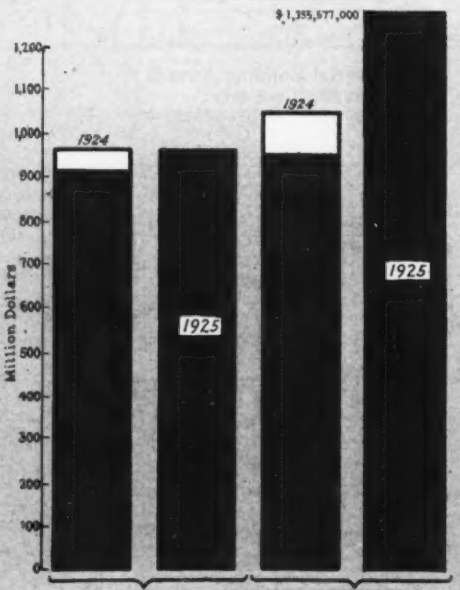
General Business Trend
Bank Debits—Federal Reserve



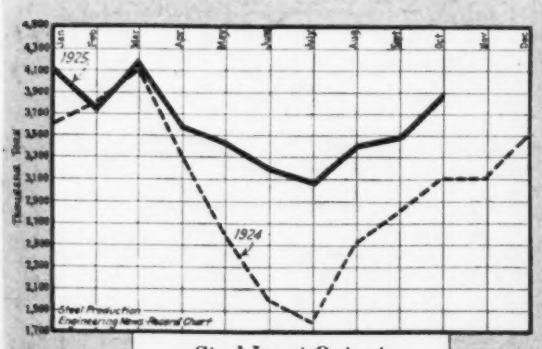
Cement Mill Stocks
Geological Survey



Unfilled Tonnage
On Books of U. S. Steel Corp.



Public—Contracts—Private
Jan. 1 to date
Reported by E. N.-R.



Steel Ingot Output
Gross Tons; Am. Iron and Steel Inst.

November Contracts Reach Record Total for That Month—This Year to Date 25 Per Cent Ahead of Last

NOVEMBER was the fourth consecutive record month in money value of contracts let and also showed the heaviest actual physical volume for that period, since 1913.

Compared with November, 1924, there was a gain of 50 per cent in total money value. Bridges, excavating jobs and large commercial buildings more than doubled the lettings of a year ago. Substantial gains also occurred in industrial buildings, streets and roads, and sewers. Water-works, Federal Government projects and the various unclassified jobs fell off considerably compared with November of last year.

With a minimum of $15,000 on waterworks and excavations, $25,000 on other public works, $40,000 for industrial, and $150,000 for commercial and other buildings, the following tabulation shows lettings for the month of November (entire U. S.) from 1913 to 1925:

1913.....	$54,021,507	1920.....	$66,263,304
1914.....	33,523,467	1921.....	82,372,446
1915.....	74,421,444	1922.....	*127,684,000
1916.....	*90,708,000	1923.....	*152,539,000
1917.....	*74,030,469	1924.....	123,994,000
1918.....	59,335,280	1925.....	185,600,000
1919.....	67,893,297	*Five issues of E.N.-R.	

Contract letting Jan. 1 to date is 25 per cent ahead of same period in 1924.

Taking 1913 as 100, November Volume Index numbers for the twelve years, follow: 1914, 84; 1915, 150; 1916, 94; 1917, 76; 1918, 66; 1919, 71; 1920, 57; 1921, 106; 1922, 114; 1923, 121; 1924, 128; 1925, 194.

Aside from the fact that it was a record month, another notable feature of November construction was the decided pick-up in the states where inactivity had previously been very marked, namely, North and South Dakota, Colorado, New Mexico, and Idaho. Substantial gains over the month preceding also occurred in Florida, North and South Carolina, Georgia, Mississippi, Louisiana, Indiana, Missouri, and Oregon. The six biggest jobs of the month were: A hotel, Park Ave. at 88th St., New York, N. Y., $8,500,000; hotel, for Continental Hotel Co., at Philadelphia, Pa., $8,000,000; loft building, 7th Ave. at 23rd St., New York, N. Y., $7,000,000; hotel, for Hotel Holding Corp., at Los Angeles, Calif., $3,500,000; subway, Sect. 7, R. 78, New York, N. Y., $3,382,263; sewage treatment plant, Chicago, Ill., $3,125,000.

Value of Contracts Let in the United States and Canada, November, 1925

	New England	Middle Atlantic	Southern	Middle West	West of Mississippi	Far West	United States	U. S. Jan. 1 to Dec. 1	Canada
Waterworks	$50,000	$1,289,000	$136,000	$626,000	$942,000	$55,000	$3,098,000	$67,452,000	$107,000
Sewers	681,000	3,062,000	40,000	3,874,000	144,000	433,000	8,234,000	80,415,000	119,000
Bridges	.....	1,352,000	802,000	564,000	1,269,000	808,000	4,795,000	60,448,000	1,000,000
Excavation, dredging, etc.	.....	58,000	1,723,000	.....	172,000	413,000	2,366,000	35,958,000	480,000
Streets and roads	44,000	3,504,000	7,532,000	5,523,000	5,423,000	1,466,000	23,492,000	402,419,000	331,000
Industrial building	2,170,000	4,020,000	652,000	4,780,000	1,780,000	2,500,000	15,902,000	216,110,000	340,000
Commercial building	7,376,000	48,909,000	9,418,000	20,382,000	13,518,000	14,988,000	114,591,000	1,223,282,000	1,918,000
Federal government	101,000	314,000	692,000	251,000	74,000	142,000	1,574,000	31,374,000	.....
Unclassified	1,096,000	1,720,000	44,000	2,378,000	2,482,000	3,828,000	11,548,000	201,855,000	1,690,000
Nov., 1925	$11,518,000	$64,228,000	$21,039,000	$38,378,000	$25,804,000	$24,663,000	$185,600,000	$2,319,313,000	$5,985,000
Nov., 1924	10,801,000	36,015,000	11,991,000	23,937,000	27,595,000	13,655,000	123,994,000	.....	6,163,000
1925, Jan. 1 to Dec. 1	187,328,000	834,355,000	224,386,000	424,618,000	386,238,000	262,218,000	2,319,313,000	.....	181,558,000
1924, Jan. 1 to Dec. 1	135,895,000	562,885,000	201,771,000	393,358,000	317,973,000	246,211,000	1,858,094,000	.....	89,346,000

Labor Rates and Conditions Throughout the Country

CONSISTENT with the optimistic reports coming in from nearly all basic industries except coal mining, construction shows an unprecedented volume of work accomplished for this particular season of the year.

Among the many obvious proofs of current prosperity, the most important may be briefly outlined as follows: Gain in bank debits or check payments; increased iron and steel output; better prices to manufacturers for general wholesale commodities but without abrupt rise; show of recovery in the stock market following recent slump; favorable trade balance with slight excess of exports; improvement in shoe and textile demand; sufficient gold imports to discourage further advance in the money rate; heavy loadings of less-than-car-lot freight, compared with other years; increase in employment; heavy automotive output; better relations between prices of agricultural products and those of other industries.

Opposite all these favorable factors stands the ever present danger of speculative excess.

The present practice of hand-to-mouth purchasing has already shown signs of developing into forward buying, which in turn soon becomes overbuying or the accumulation of undesirable inventories, all owing to easy credit or the fear of future price advances.

Up to Oct. 1, 1925 reserve stocks of raw materials and manufactured commodities were considerably heavier than a year ago. Over-production, however, seems due to affect manufactured commodities before it does the raw materials.

Aside from the depressing influences of the coal strike and anticipated wage demands on the part of skilled building trades mechanics, there is the prospect of an unseasonal shrinkage in construction volume during December.

Work in the projected stage as late as Oct. 1, indicates a smaller money value of lettings for December, compared with the preceding month and also with December, 1924.

Long term state and municipal borrowings or bond sales, during October, were the smallest for that month since the commencement of the building boom in 1922. A recession in the volume of public-works construction is indicated if the present trend is followed.

Local conditions in several of the most important industrial centers follow:

Birmingham—With much building in progress and under contract both skilled and common labor is in demand. There is no indication of labor trouble as all seem satisfied with prevailing rates.

Boston—Many structural iron workers are getting $1.25 per hr. although the 400 strikers who returned to work Oct. 29, did so on the basis of $1.10 per hr., the old rate. Proposal is under way to establish a rate of $1.25 per hr. for all skilled building trades, agreement to extend over two-year period from March 1, 1926, to March 1, 1928.

Chicago—Labor is well employed on the many large hotel and apartment structures now under way in this district. There is no real scarcity of skilled men and common laborers are in abundance. Payment of bonuses to bricklayers and plasterers has been abandoned.

Detroit—Supply of laborers in factories has increased at the expense of the construction jobs in the city, the men preferring inside work with the coming of cold weather.

Minneapolis — Building shortage in this district evidently made up. Number of vacant dwellings on increase.

New Orleans — Common laborers scarce in outlying districts and overplentiful in the city.

New York — Thirty-seven building crafts demand an all-around wage increase of 14 per cent to take effect Jan. 1, 1926. Bricklayers request a base rate of $16 per day as against the present scale of $12 with a bonus of $4. The movement is for the purpose of having existing bonuses written into permanent agreements with the various trades. Residential building is in the lead in this city, apartment houses forming the bulk of this class. Commercial buildings are next in importance.

Philadelphia—Drop in volume of local construction is responsible for present over-supply of carpenters, cement finishers, and bricklayers. Tile setters and plumbers in active demand. All

Current Building Trades Wage Rates Per Hour

(Higher rates indicated by +, decreases by —)

Cities	Bricklayers	Carpenters	Hoisting Engineers	Hod Carriers	Pile Drivers	Structural Iron Workers	Common Labor
Atlanta	$1.12½	$0.70	$0.70	$0.50	.....	$0.75	$0.25@.30
Baltimore	1.50@1.75	1.00@1.20	1.00@1.12½	1.00	$0.65	1.12½	.40
Birmingham	1.00@1.50	.35@.87½	.75@1.25	.50@.75	.....	.75@1.75	.20@.40
Boston	1.25	1.10	1.10@1.30	.70@.75	1.10	1.10	.50@.75
Cincinnati	1.50	1.25	1.25	.92½	1.25	1.25	40@55
Chicago	1.50	1.37½	1.37½	.87½	1.37½	1.37½	.82½@.87½
Cleveland	1.50	1.25	1.30	.87½	1.00	1.50	.87½
Dallas	1.62½	1.00	1.00	.40@.75	.87½	1.00	.30@.50
Denver	1.62½	1.12½	1.12½@1.18¾	.81¼@.87½	1.00	1.15¾	.35@.55
Detroit	1.50	.70@1.00	.85@1.00	.90	.85@1.00	1.12½	.50@.60
Kansas City	1.37½	1.25	+1.15@1.25	90	—1.00	+1.17½	.40@.75
Los Angeles	+1.37½	.93¾	1.00	....	.81¼	1.00	.50
Minneapolis	1.12½@1.25	.87½@90	.87½	.71½	.....	.87½	.45@.55
Montreal	— 90	.65	— .56¾	—25 @.30	.50	.80	— 20@.30
New Orleans	1.25	.90	1.00	.65	.85	1.25	.35@.40
New York	1.50	1.31¼	1.50	1.00	1.00@1.12½	1.50	.62½@.75
Philadelphia	1.50	1.12½	1.02½	1.12½	1.00	1.12½@1.25	.45@.50
Pittsburgh	1.62½	1.37½	1.37½@1.43¾	1.09⅜	.....	1.43¾	.75
St. Louis	1.75	1.50	1.50@1.65	1.15@1.25	1.50	1.50	.45@1.00
San Francisco	1.25	1.00	1.00	.81¼	1.00	1.12½	.50@.55
Seattle	1.37½	1.12½	1.00@1.12½	1.00	1.00@1.12½	1.12½	.50@.62½

crafts are expected to move for higher wage rates in 1926.

Seattle—Slackening in demand for mechanics on large building operations. Conditions better than a year ago this time. Slight unemployment predicted for coming winter season unless increased activity at lumber camps and mills absorbs surplus.

Monthly Prices of Construction Materials

Ups and Downs of the Market

NOVEMBER construction volume was heavier than the month preceding with no notable advance in costs. There is firmness with upward trend in the current market for iron and steel, railway materials, c.-i. pipe, brick, tile, pine lumber, scrap, rivets, water and sewage treatment chemicals. Florida requirements are responsible for the unseasonal demand. A tendency to decline is noted in cement, cut nails, linseed oil, red and white lead. Steel pipe, standard rails and tin plates have not changed in price since 1922. There is firmness with little tendency to change in road and paving materials and aggregates.

Pig Iron—Buying is slight for first quarter delivery, despite threats of a bituminous coal strike. All grades are about $2 per ton above a month ago and $2 to $3 higher than in December, 1924. At Birmingham some small lots of No 2 foundry have recently sold for $23 per ton. All furnaces are operating, with good demand. There is but little pig iron on the yards at this time.

Railway Supplies—Buying of track supplies and cars continues active. Rail orders are a trifle slower, following recent spurt. The market is higher than a month ago in light and re-rolled rails, spikes, track bolts, and angle bars. Ties are firm and unchanged. Standard rails remain at prices in effect three years ago.

Pipe—Mill prices of steel pipe have not changed materially since the early part of 1922. Demand is seasonally slow. Cast-iron pipe is about $1 per ton above the November level and considerably below a year ago. There is some slight fluctuation in sewer pipe but without any definite upward or downward trend. Clay drain tile remains firm and unchanged.

Road and Paving Materials—Aside from slight fluctuations in prices of wood blocks and paving stone in the Kansas City district, there were no changes in the twenty-one cities reporting to *Engineering News-Record*, in road oils, asphalt, paving stone, flagging, curbing, and wood blocks.

Sand, Gravel and Crushed Stone—Gravel and crushed stone remain firm and unchanged in most of the principal cities. Detroit, however, reports a rise of 12c. per cu.yd. in sand. Advances are expected as colder weather approaches.

Lime and Cement—Lime is higher than a month ago in Boston and St. Louis and down in Kansas City, Montreal and Detroit. Portland cement dropped 10 to 20c. per bbl. in several of the western mills, during the month. Present seasonal accumulation of stocks at mills will probably continue until March, 1926.

Brick and Hollow Tile—Both materials are tending upward in the New York market. The former shows a drop of $1 per M. at Philadelphia yards and the latter, slight declines in Denver and Detroit.

Structural Steel — Production is heavy and demand particularly active in the construction, automotive and agricultural implement industries. Bars, sheets, tin plates, hoop steel and semi-finished material are moving in substantial volume in the current market. Reinforcing bars are about 10c. per 100 lb. above the November level at mills; plates are up 5c. per 100 lb.; shapes remain unchanged, except that the $1.90 figure applies to exceptional tonnages, $2 to single carloads and $2.10 per 100 lb. to less than carload quantities at Pittsburgh mills.

Lumber—Pine demand is unusually heavy in the Florida boom area with buying active in flooring, lath, special cutting, boards, and dimension lumber. Prices of long-leaf yellow pine in other districts are firm and unchanged. Fir cutting is slowing down to a point consistent with demand. The only notable price fluctuations in Douglas fir during the month, occurred in 1-in. boards at Denver, Minneapolis and Kansas City yards.

Iron and Steel Scrap—Prices are firmer, consistent with the upward trend in iron and steel.

Miscellaneous—Prices of structural and boiler rivets, water and sewage treatment chemicals are higher than a month ago. The general tendency is downward in cut nails, linseed oil, red and white lead, and manila rope.

E. N.-R. Prices of Construction Materials

Price advances since last month are indicated by **heavy type**; declines by *italics*

PIG IRON—Per Gross Ton f.o.b.:

	Dec. 3	One Year Ago
CINCINNATI		
No. 2 Southern (silicon 2.25@2.75)	**$24.05**	$22.55
Northern Basic	**24.27**	21.77
Southern Ohio No. 2 (silicon 1.75@2.25)	**24.27**	22.27
NEW YORK, tidewater delivery		
Southern No. 2 (silicon 2.25@2.75)	**28.37**	25.10
BIRMINGHAM		
No. 2 Foundry (silicon 2.25@2.75)	**22.00@23.00**	19.00@20.00
PHILADELPHIA		
Eastern Pa., No. 2X (2.25@2.75 sil.)	**24.16**	22.50
Virginia No. 2 (silicon 2.25@2.75)	29.17	29.75
Basic	**23.16**	21.75
Gray Forge	....	21.75
CHICAGO		
No. 2 Foundry Local (silicon 1.75@2.25)	**23.60**	20.50
No. 2 Foundry Southern (silicon 2.25@2.75)	**26.55**	25.00
PITTSBURGH, including freight charge ($1.76) from the Valley		
No. 2 Foundry Valley (silicon 1.75@2.25)	**22.27**	22.77
Basic	**22.27**	22.77
Bessemer	**22.27**	23.77

SCRAP—The prices following are f.o.b. per ton paid by dealers:

	New York	Chicago	Birmingham
No. 1 railroad wrought	**$15.75**	**$15.50@$16.00**	**$13.00@$13.50**
Stove plate	**11.60**	**15.50@16.00**	**14.60@14.50**
No. 1 machinery cast	**18.75**	**17.50@18.00**	**17.00@17.50**
Machine shop turnings	**10.75**	9.75@10.25	**8.00@8.50**
Cast borings	**12.60**	**12.00@12.50**	**8.00@8.50**
Railroad malleable	**17.00**	**17.00@17.50**	17.00@18.00
Re-rolling rails	**14.75**	17.00@17.50	16.50@17.00
Re-laying rails	23.50	.....	21.00@22.00
Heavy melting steel	**13.00**	**14.50@15.00**	.....

Railway Supplies

STEEL RAILS—The following quotations are per ton f.o.b. for carload or larger lots. For less than carload lots 5c. per 100 lb. is charged extra:

	Pittsburgh				
	Dec. 3	One Year Ago	Birmingham	Chicago	St. Louis
Standard bessemer rails	$43.00	$43.00	$43.00	$43.00	$47@49
Standard openhearth rails	43.00	43.00	43.00	43.00	49@50
Light rails, 8 to 10 lb.	.....	36@37	34@35	1.80@1.90	.....
Light rails, 12 to 14 lb.	.....	36@37	34@36	1.80@1.90	1.90@1.95*
Light rails, 25 to 45 lb.	**36@38**	36@37	34@36	1.80@1.90	1.85@1.90*
Re-rolled rails	**30@34**	30@34	.....	.....	18.50

*Per 100 lb.

RAILWAY TIES—For fair-sized orders, the following prices per tie hold:

	6 In. x 8 In. by 8 Ft.	7 In. x 9 In. by 8½ Ft.
Chicago, white oak, plain	$1.40	$1.75
Chicago, empty cell creosoted	1.75	2.10
Chicago, zinc treated	1.55	1.90
San Francisco, green Douglas fir	.84	1.14
San Francisco, empty cell creosoted, Douglas fir	1.70	2.25
St. Louis, white oak, plain	1.10	1.30
St. Louis, zinc treated	1.50	1.70
St. Louis, red oak, plain	1.00	1.20
St. Louis, sap pine-cypress	.85	1.05
Birmingham, white oak	1.25	1.45

TRACK SUPPLIES—The following prices are base per 100 lb. f.o.b. Pittsburgh mill for carload lots, together with the warehouse prices at the places named:

	Pittsburgh				San	
	Dec. 3	One Year Ago	Chicago	St. Louis	Francisco	Birmingham
Standard spikes, ⅝-in. and larger	**$2.90@3.00**	$2.80	$3.55	3.65@**3.75**	$4.35	$2.90
Track bolts	3.90@4.15	3.75@4.00	4.55	**4.25@4.35**	5.85	3.90
Standard section angle bars	2.75	2.75	**3.40**	3.25@3.75	4.00	3.85

Pipe

WROUGHT PIPE—The following discounts are to jobbers for carload lots at Pittsburgh mill:

BUTT WELD

Inches	Steel Black	Steel Galv.	Inches	Iron Black	Iron Galv.
1 to 3	62	50½	1 to 1½	30	13

LAP WELD

2	55	43½	2	23	7
2½ to 6	59	47½	2½	26	11
7 and 8	56	43½	3 to 6	28	13
9 and 10	54	41½	7 to 12	26	11
11 and 12	53	40½			

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1½	60	49½	1 to 1½	30	14
2 to 3	61	50½			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	53	42½	2	23	9
2½ to 4	57	46½	2½ to 4	29	15
4½ to 6	56	45½	4½ to 6	28	14
7 and 8	52	39½	7 and 8	21	7
9 and 10	45	32½	9 to 12	16	2
11 and 12	44	31½			

STEEL PIPE—From warehouses at the places named the following discounts hold for welded steel pipe:

	Black			
	New York	Chicago	Birmingham	St. Louis
1 to 3 in. butt welded	53%	54%	**49%**	49%
3½ to 6 in. lap welded	48%	51%	**46%**	46%

	Galvanized			
	New York	Chicago	Birmingham	St. Louis
1 to 3 in. butt welded	39%	41%	**36%**	36%
3½ to 6 in. lap welded	35%	38%	**33%**	33%

Malleable fittings, Classes B and C, banded, from New York stock sell at list plus 4% less 5%. Cast iron, standard sizes, 36—5% off.

CAST-IRON PIPE—The following are prices per net ton for carload lots:

	Birmingham	Burlington, N. J.	New York Dec. 3	New York One Year Ago
4 in.	$45.00	**$53.00@$55.00**	**$55.60@57.60**	$60.60@61.60
6 in. and over	41.00@42.00	48.00@**50.00**	50.60@**52.60**	55.60@56.60

	Pittsburgh	Chicago	St. Louis	San Francisco
4 in.	*$51.00@52.00*	$53.20@54.20	$52.00	$57.00
6 in. and over	*47.00@50.00*	49.20@50.20	48.00	53.00

Gas pipe and Class "A," $4 per ton extra.

CLAY DRAIN TILE—The following prices are per 1,000 lin.ft.:

	New York					
Size, In.	Dec. 3	One Year Ago	St. Louis	Birmingham	San Francisco	Dallas
3	$48.00	$45.00	$40.00	$45.00	.....	$73.00
4	50.00	55.00	40.00	56.00	$76.50	110.00
5	70.00	80.00	.....	80.00	97.75	118.00
6	92.00	105.00	70.00	100.00	127.50	150.00
8	160.00	170.00	170.00	165.00	212.50	210.00

SEWER PIPE—The following prices are in cents per foot for standard pipe in car load lots, f.o.b., except as otherwise stated:

Size, In.	New York Delivered	Pittsburgh	Birmingham	St. Louis	Chicago	San Francisco	Dallas
3	....	$0.081	$0.10	.....	$0.09	$0.12	.....
4	....	.081	.10	$0.10	.09	.15	$0.15
5	....	.1215	.135	.....	.13½	.18	.18
6	$0.21	.1215	.135	.14	.13½	.21	.21
8	.35	.189	.21	.225	.21	.30	.325
10	.52	.2835	.315	.315	.31½	.42	.476
12	.66	.3645	.45	.405†	.40½	.56	.612
15	1.14†	.486	.54	.675†	.54	.92	1.02
18	1.65†	.675	.75	.945†	.75	1.32	1.53
20	1.98†	.81	.90	1.26†	.90	.....	.....
22	2.65†	1.08	1.20	.....	1.20	.....	1.564
24	2.97†	1.215	1.35	1.62†	1.35	2.16	2.04
27	4.65†	2.405	2.665	2.45†	2.75	3.00	3.34
30	5.16†	2.664	2.952	3.00†	3.75	3.60	4.06
33	6.98†	3.60	3.96	3.55†	4.50	.....	4.99
36	8.00†	4.10	4.51	3.95†	5.00	.....	5.42

	3	5	8	12	24	36
Boston	$0.13	$0.20	$0.30	$0.60	$2.00†	$5.50†
Minneapolis	.....	.....	.225	.405	1.35	4.75
Denver	.135*	.18*	.27	.47	**1.70**	.....
Seattle	.14	.....	.35	.72†	2.60†	.....
Los Angeles	.1625	.195	.275	.495	1.65	.....
New Orleans	.115*	.117*	.295	.4725	1.575	.....
Cincinnati	.105	.1575	.245	.4725	1.575	4.715
Atlanta	.10*	.15*	.24	.40	1.55	.....
Montreal	.68‡	.45†	.70	1.35	4.50†	.....
Detroit	**.11**	**.1665**	**.259**	**.4995**	**2.25†**	**7.175†**
Baltimore	.11	**.166**	.259	.499	1.665	4.92
Kansas City, Mo.	.13½	.15	**.32**	.52	2.16	5.06
Philadelphia	*.11*	*.17*	*.26*	*.50*	*1.67*	*3.80*

*4-in., 6-in., 9-in., respectively. †Double Strength. ‡3-in. special.

Road and Paving Materials

ROAD OILS—Following are prices per gallon in tank cars, 8,000 gal. minimum f.o.b. place named:

		Dec. 3	One Year Ago
New York, 45% asphalt	(at terminal)	$0.065 @ $0.07	$0.07
New York, 65% asphalt	(at terminal)	.0675@ .0725	.0725
New York, binder	(at terminal)	.07 @ .075	.075
New York, flux	(at terminal)	.07 @ .075	.075
New York, liquid asphalt	(at terminal)	.07 @ .075	.075
St. Louis, 40@50% asphalt		.05½	.0475
St. Louis, 50@60% asphalt		.05½	.0481
Birmingham, 55% asphalt		.0475	.....
Dallas, 45% asphalt		.0495	.0495
Dallas, 55% asphalt		.0455	.0455
Dallas, binder		.061	.061
San Francisco, binder, per ton		12.00*	11.00*

* F.o.b. Oleum, Cal. Freight to San Francisco, 80c. per ton.

E. N.-R. Prices of Construction Materials

ASPHALT—Price per ton in packages (350-lb. bbls. or 325-lb. drums) and in bulk in carload lots, f.o.b. points listed:

	Package	Bulk
New York (*Texas*)	$23.00*	$18.50
Boston (*Mexican*)	22.50	18.50
Chicago (*Texas*)	27.00	23.00
San Francisco, *f.o.b. refinery*, Oleum, Cal.	18.00	12.00
Dallas (*Texas*)	27.10	21.10
Seattle, *"D" grade, California, f.o.b. Richmond*	19.50	13.50
Denver (*California*)	24.00	.....
Minneapolis, *f.o.b. Twin Cities (Standard)*	27.60	21.60
St. Louis (*Mexican*)	25.00	21.00
Baltimore (*Mexican*) (*f. o. b. refinery*)	22.50	18.50
Montreal (*Imperial*)	28.00	21.00
Atlanta (*Mexican*)	26.10	21.90
Detroit (*Mexican*)	27.00	23.00
Cincinnati (*Kentucky Rock*)	.....	11.65
Maurer, N. J. (*Bermudez*)	28.00	26.00
Maurer, N. J. (*Mexican*)	22.00	19.00
Philadelphia (*Mexican*)	24.00	22.00
Kansas City, Mo. (*Texas*)	27.30	22.30
Los Angeles (*"D" grade, California*)	19.50†	13.50†
Birmingham (*Mexican*)	27.00	21.00
New Orleans (*Mexican*)	26.00	17.00

*In drums. †f.o.b. El Segundo Refinery.

NOTE—Barrels or drums are optional in most cities. About 6 bbls. to the ton, and from 4 to 5 drums; 200 to 300 gal. to the ton.

PAVING STONE—

New York (grade 1)	5-in. granite, 30 blocks per sq.yd.	$147.00 per M.
San Francisco	Basalt block 4x7x8	70.00 per M.
Chicago	about 5x8x5 dressed	3.60 per sq.yd.
	about 5x8x5 common	3.25 per sq.yd.
Boston	5-in. Granite	135.00 per M.
Atlanta	Granite	2.50 per sq.yd.
Detroit	5-in. Granite	3.00 per sq.yd.
Baltimore	Granite	2.85 per sq.yd.
Montreal	Granite	104.75 per M.
New Orleans	Granite, 4x8x4	*3.18* per sq.yd.
Cincinnati	Granite	135.00 per M.
St. Louis	Granite, 4x8x4	1.65 per sq.yd.
Kansas City	Granite	*3.85* per sq.yd.
Philadelphia	Granite	3.90@4.25 per sq.yd.
Minneapolis	Sandstone	2.74 per sq.yd.

FLAGGING—

New York	Bronx, 4 ft. wide	$0.24 per sq.ft.
	Manhattan, 4 ft. wide	.24 per sq ft.
	Queens, 5 ft. wide	.26 per sq.ft.
	6x24-in. cross-walk	1.30 per lin.ft.

CURBING—*New York*: Bluestone per lin.ft., f.o.b. barge New York, 5x16 in., 88c.; *St. Louis*: Class "A" straight, delivered, 5x18 in., $1.05 per lin.ft.; roundings, $1.60. *Birmingham*: Limestone, 5x18-in., $1.05 per lin. ft.

WOOD BLOCK PAVING—

	Size of Block	Treatment	Per Sq.Yd
New York	3	16	$2.40
New York	3½	16	2.70
Boston	3½	18	2.50
Chicago	4	16	2.25
Chicago	3½	16	2.10
St. Louis	3½	16	2.40
St. Louis	4	16	2.70
Seattle	4	16	Off market
Minneapolis	3½	16	2.40
Atlanta	3½	16	2.00
New Orleans	3	16	2.20
New Orleans	3½	16	2.30
New Orleans	4	16	2.40
Dallas	4	18	3.90
Baltimore	3½	16	None used
Montreal	4	16	4.50
Detroit	3	16	1.94
Detroit	4	16	.....
Cincinnati	3½	16	2.35
Kansas City	4	16	4.15
Philadelphia	4	16	None used

Construction Materials

SAND AND GRAVEL—Price for cargo or carload lots to contractor f.o.b., per cu.yd. is as follows:

	Gravel 1½ In.		Gravel ¾ In.		Sand	
	Dec. 3	One Year Ago	Dec. 3	One Year Ago	Dec. 3	One Year Ago
New York (*alongside dock*)	$1.75	$2.00	$1.75	$2.00	$1.00	$1.00
Denver	1.90	1.90	1.90	1.90	1.00	1.00
Chicago	1.50	.....	1.50	.....	1.40	.....
St. Louis	1.45	1.45†	1.45	1.45†	1.08	1.18†
Seattle	1.50	1.50	1.50	1.50	1.50	1.50
Dallas	2.38	2.38	2.38	2.38	2.00	2.00
Minneapolis	1.65*	1.65*	1.65*	1.65*	1.25	1.25
Cincinnati	1.40†	1.40†	1.40†	1.40†	1.35†	1.35†
San Francisco	2.15	2.15	2.15	2.15	1.50	1.50
Boston	1.50†	1.50†	1.50†	1.50†	1.00†	1.00†
New Orleans	2.60	3.00	2.60	3.00	1.75	1.25
Los Angeles	0.85*†	1.50†	0.85*†	1.55†	0.50*†	1.10†
Atlanta	2.20†	1.90†	2.20	1.90†	1.65†	1.40†
Detroit	2.02	2.02	2.02	2.02	1.62	1.62
Baltimore	1.40	1.40	1.60	1.60	0.70*†0.70*†	
Montreal	1.25†	1.25†	1.25†	1.50†	1.25†	1.25†
Birmingham	2.00	2.00	2.00	2.00	1.50	1.30†
Philadelphia	2.10	2.10	2.10	2.10	1.50	1.50
Kansas City	1.50	4.00	1.50	4.00	0.66*†0.66*†	

New York—Grits, $1.75 per cu. yd.; ready mixed, $1.90.
Los Angeles—Freight from quarry, 70c. per ton, and is included in above price.
*At pit. † Per ton.

CRUSHED STONE—Price for cargo or carload lots, per cu.yd. f.o.b. city, is as follows:

	1½ In.		¾ In.	
	Dec. 3	One Year Ago	Dec. 3	One Year Ago
New York	$1.75	$1.75	$1.85	$1.85
Chicago	1.72½	.....	1.87½	.....
St. Louis	1.93*	1.75*	1.93*	1.75*
Dallas	2.40	2.40	2.83	2.83
San Francisco	2.15	2.15	2.15	2.15
Boston	1.60*	1.60*	1.60*	1.60*
Minneapolis	1.75	1.75	1.75	1.75
Kansas City (*Joplin chats*)	4.00	1.50	4.00	1.50
Denver	2.50	3.50	2.50	2.50
Seattle	3.00	3.00	3.00	3.00
Atlanta	2.20*	2.00*	2.20*	2.00*
Cincinnati	1.90*	1.90*	1.90*	1.90*
Los Angeles	1.00*	1.65*	1.00*	1.75*
Detroit	2.00*	1.70	2.00*	1.70
Baltimore	2.50	2.50	2.55	2.55
Montreal	1.80*	1.80*	1.50*	2.25*
Philadelphia	2.10	2.10	2.10	2.10
Pittsburgh	2.85	2.85	2.85	2.85
Cleveland	3.25*	3.25*	3.25*	3.25*
Birmingham	2.00	1.00	2.00	1.20

*Per ton.

CRUSHED SLAG—Price of crushed slag in carload lots, per net ton, at plant

	1½-In.	¾-In.	Roofing	Sand
Youngstown District	$1.25	$1.35	$2.00	$1.25
Steubenville District	1.25	1.30	2.00	1.30
Ironton District	1.40	1.40	2.00	1.40
Easton, Catasauqua, Pa.	.....	.....	2.50	.....
Birmingham, Ala.	.80@.90	1.15	2.05	.....
Buffalo, N. Y., and Erie, Pa.	1.25	1.25	2.25	1.25
Cleveland, Ohio	1.30	1.30	1.30	1.30
Eastern Pa. and Northern N. J.	1.25	1.25	2.50	1.25
Western Pennsylvania	1.25	1.25	2.50	1.25
Longdale and Glen Wilton, Va.	1.25	1.25	2.50	.....
Toledo, Ohio	1.25	1.25	1.50	1.25

LIME—Warehouse prices:

	Hydrated, per Ton		Lump, per Barrel	
	Finishing	Common	Finishing	Common
New York	$18.20	$12.00@$13.10	$3.50*	$2.25@2.75*
Chicago	20.00	18.00	.....	1.30†
St. Louis	24.00	20.00	15.00‡	15.00‡
Boston	20.00	13.00@14.50	3.75*	3.00*
Dallas	20.00	.....	.....	1.85†
Cincinnati	16.80	14.30	.....	13.40‡
San Francisco	22.00	.....	.....	1.60†
Minneapolis	25.50	21.00 (white)	1.60@1.70†	1.35†
Denver	24.00	.....	.....	2.70*
Detroit	*15.50*	*12.50*	.....	*16.00*‡
Seattle, *paper sacks*	24.00	.....	2.80†	.....
Los Angeles	25.00	18.00	3.50	19.50‡
Baltimore	24.25	17.85	2.55†	.....
Montreal	.....	21.00	.....	*10.00*‡
Atlanta	22.50	14.00	2.00†	1.30†
New Orleans	24.00	16.00	2.50†	2.00*
Philadelphia	23.00	.....	1.21†	.....
Kansas City	*18.50*	*15.00*	*2.25**	2.10*
Birmingham	22.50	15.00	2.40†	1.85†

*Per 280-lb. bbl. (net). †Per 180-lb. bbl. (net). ‡Per ton.

NATURAL CEMENT—Price to dealers per bbl. for 500 bbl. or over, exclusive of bags:

	Dec. 3	One Year Ago
Minneapolis (Rosendale)	$2.80	$2.80
Kansas City (Ft. Scott)	*1.35*	1.50
Cincinnati (Utica)	1.72	1.72
Boston (Rosendale)	2.75	2.50
St. Louis (Carney)	2.50	2.35
Birmingham (Magnolia) pozzolan cement	2.40	2.25

PORTLAND CEMENT—Prices to contractors per bbl. in carload lots f.o.b points listed *without bags*. Cash discount not deducted.

	Dec. 3	One Month Ago	One Year Ago
New York, del. by truck	$2.50@2.70	$2.50@2.60	$2.50@2.60
New York, alongside dock to dealers	2.15	2.15	2.15
Jersey City	2.33	2.33	2.33
Boston	2.40	2.40	2.67½
Chicago	2.10	2.10	2.20
Pittsburgh	2.09	2.09	2.19
Cleveland	2.29	2.29	2.39
Detroit	2.15	2.15	2.40
Indianapolis	2.29	2.29	2.41
Milwaukee	2.25	2.35	2.35
Duluth	2.09	2.09	2.19
Peoria	2.27	2.27	2.37
Cedar Rapids	2.34	2.34	2.44
Davenport	2.29	2.29	2.39
St. Louis	2.20	2.20	2.30
San Francisco	2.31	2.31	2.61
New Orleans	2.40	2.40	2.40
Minneapolis	2.32	2.32	2.42
Denver	2.84	2.84	2.84
Seattle	2.65	2.65	2.65
Dallas	2.05	2.05	2.05
Atlanta	2.35	2.25	2.35
Cincinnati	2.37	2.37	2.47
Los Angeles	2.52	2.52	2.60
Baltimore	2.50	2.50	2.50
Birmingham	2.40	2.40	2.40
Kansas City, Mo.	2.30	2.36	2.07
Montreal	1.80	1.80	1.80
Philadelphia	2.41	2.41	2.41
St. Paul	2.32	2.32	2.42
Toledo	2.20	2.20	2.45

NOTE—Bags 10c. each, 40c. per bbl.; 20c. each in Canada, 80c. per bbl.

Current mill-prices per barrel in carload lots, without bags, to contractors:

Buffington, Ind.	$1.85	Hudson, N. Y.	$2.05
Universal, Pa.	1.85	Leeds, Ala.	1.95
Steelton, Minn.	1.90	Hannibal, Mo.	*1.95*
Fordwick, Va.	2.05	Lehigh Valley District	1.95
Mitchell, Ind.	*1.95*	Wyandotte, Mich.	*1.90*
Iola, Kan.	*1.85*	Alpena, Mich.	*1.75*
Mason City, Ia.	*1.90*	Richard City, Tenn.	2.05
La Salle, Ill.	*1.95*	Kingsport, Tenn.	2.05

E. N.-R. Prices of Construction Materials

TRIANGLE MESH—Price per 100 sq.ft. in carload lots:

PLAIN 4-INCH BY 4-INCH MESH

Style Number	Weight in Pounds per 100 sq.ft.	Pittsburgh Mill	Chicago District Mill	Warehouse: New York	St. Louis	Dallas	San Francisco
032	22	$0.97	$1.01	$1.39	$1.06	$1.13	$1.22
049	28	1.23	1.29	1.76	1.35	1.38	1.55
068	35	1.51	1.58	2.16	1.66	1.67	1.91
093	45	1.94	2.03	2.77	2.13	2.00	2.46
126	57	2.39	2.51	3.45	2.63	2.55	3.03
153	68	2.86	2.99	4.11	3.14	3.15	.....
180	78	3.28	3.43	5.70	3.60	3.47	.....
245	103	4.33	4.53	6.21	4.75	4.58	.....
287	119	5.00	5.24	7.19	5.50	5.26	6.35
336	138	5.80	6.07	8.35	6.37	6.11	.....
395	160	6.72	7.04	9.65	7.38	7.12	.....
		PAVING					
036P	17	$0.74	$0.77	$1.06	$0.81	$0.76	.....
053P	24	1.04	1.09	1.50	1.14	1.07	.....
072P	31	1.32	1.38	1.90	1.45	1.39	.....
097P	40	1.70	1.78	2.45	1.87	1.90	.....
049R	24	1.04	1.09	.....	1.14	1.07	.....
067R	31	1.32	1.38	.....	1.45	1.39	.....
089R	40	1.70	1.78	.....	1.87	1.90	.....

In rolls, 48-, 52-, and 56-in. wide and in 150-, 200- and 300-ft. lengths. Galvanized is about 15% higher. Size of roll carried in New York warehouses, 48 in. wide x 150 ft. long, or 600 sq.ft.

EXPANDED METAL LATH—Prices in carload lots per 100 yd. for painted:

Weight in pounds	New York	Birmingham	Chicago	St. Louis	San Francisco	Dallas
2.2	$19.00	$22.00	*$19.00*	$19.00	$24.00	$23.50
2.5	21.00	23.00	*21.00*	21.00	26.00	25.00
3.0	24.00	26.00	*24.00*	24.50	30.00	28.50
3.4	26.00	28.00	*26.00*	26.50	33.00	31.00

BARS, CONCRETE REINFORCING—Current quotations per 100 lb.:

ROLLED FROM BILLETS

Inches	Pittsburgh Mill	Birmingham	Warehouse, Uncut: New York	Chicago	St. Louis	Dallas	San Francisco
¼ and larger	$2.00@$2.10	$2.25	$3.24	$3.00	$3.15@3.25	$3.38	$3.35
⅜	2.10@2.20	2.35	3.34	3.10	3.25@3.35	3.43	3.45
½	2.20@2.30	2.45	3.44	3.20	3.35@3.45	3.48	3.55
⅝	2.40@2.50	2.65	3.64	3.40	3.55@3.65	3.63	3.75
¾	3.00@3.10	3.25	4.24	4.00	4.15@4.25	3.78	4.35

For standard classification of extras for size and cutting of steel bars, see bar card of July 15, 1923.

ROLLED FROM RAILS

	St. Louis	Dallas		St. Louis	Dallas
¼ and larger	$2.55@2.65	$2.80	⅝	$2.95@3.05	$3.02
⅜ in.	2.65@2.75	2.85	¾	3.55@3.65	3.50
½	2.75@2.85	2.90		.....	.....

BRICK—Contractors price per 1,000 in cargo or carload lots is as follows:

	Common: Dec. 3	Common: One Month Ago	Common: One Year Ago	Paving Block: 3-inch*	Paving Block: 3½-inch*
New York (del.)	$17.50@19.50	$17.50@18.50	$18.00	$45.00	$51.00
New York (at dock)	14.50@16.50	14.50@15.50	15.00	.....	.....
Chicago	12.00	12.00	.....	42.00	45.00
St. Louis, salmon (del.)	16.00	16.00	14@16	40.00	42.50
Denver, salmon	12.00	12.00	12.00	.....	.....
Dallas	11.10	11.10	12.10	35.00	.....
San Francisco	15.50	15.50	15.50	.....	.....
Los Angeles	11.50	11.50	15.00	(not used)	
Boston (del.)	17.50	17.50	21.00	45.00	*50.00*
Minneapolis (del.)	13.50	13.50	15.00	.....	.....
Kansas City	14.50	14.50	14.50	(no market)	
Seattle	15.00	15.00	15.00	.....	42.50
Cincinnati	17.00	17.00	17.00	40.00	45.00
Montreal	17.50	17.50	17.50	100.00†	68.00
Detroit (del.)	16.00	16.00	17.50	37.50	40.50
Baltimore	18.00	18.00	18.00	40.00	45.00
Atlanta	10.50	10.50	10.50	40.00	.....
New Orleans	15.00	15.00	17.50	.....	.....
Birmingham	12.50	12.50	12.50	40.00	45.00
Philadelphia	15@*18*	15@19	19.00	40.00	50.00
Pittsburgh (del.)	16.00	16.00	16.00	.....	.....
Cleveland	14.00	14.00	14.00	.....	.....

*For paving blocks 3x8½x4 and 3½x8½x4 respectively. †Imported.

HOLLOW TILE—Price per block in carload lots to contractor for hollow building tile.

	New York: Dec. 3 on Trucks*†	New York: One Year Ago	Chicago	Philadelphia	St. Louis	San Francisco†	Perth Amboy N. J., Factory*
4x12x12	$0.1112	$0.1162	$0.075	$0.12	$0.07	$0.108	.....
6x12x12	.1667	.1743	.096	.....	.095	.156	.....
8x12x12	.2084	.2179	.135	.22	.132	.244	.....
10x12x12	.....	.....	.167	.....	.165	.....	$0.252
12x12x12	.....	.....	.215	.....	.195	.....	.312

*5 per cent off for cash. †Partition tile.

	4x12x12	8x12x12	12x12x12
Boston	$0.085	$0.17	.....
Minneapolis (f.o.b. cars)	.0636	.106	$0.189
Minneapolis (delivered)	.07	.116	.205
Cincinnati	.07485	.13745	.....
Kansas City	.085	.145	.....
Denver	*.075*	.155	.188
Seattle (delivered)	.10	.20	.30
Los Angeles	.085	.172	.....
New Orleans	.13	.20	.....
Detroit (delivered)	*.095*	*.165*	.2821
Montreal	.12	.225	.30
Baltimore	.125	.27	.....
Atlanta	.0893	.1674	.....
Dallas	.10	.19	.275
Birmingham	.11	.1824	.22
Pittsburgh (delivered)	.068	.128	.179
Cleveland	.07	.149	.....

STRUCTURAL MATERIAL—Following are base prices f.o.b. mill, Pittsburgh and Birmingham, together with quotations per 100 lb. from warehouses at place named:

	Pittsburgh Mill	Birmingham	Warehouse: New York	Dallas	St. Louis	Chicago	San Francisco
Beams, 3 to 15 in.	$1.90@2.00	$2.05	$3.34	$4.15	$3.25	$3.10	$3.30
Channels, 3 to 15 in.	1.90@2.00	2.10	3.34	4.15	3.25	3.10	3.30
Angles, 3 to 16 in., ¼ in. thick	1.90@2.00	2.10	3.34	4.15	3.25	3.10	3.30
Tees, 3 in. and larger	1.90@2.00	2.10	3.34	4.15	3.35	3.10	3.30
Plates, ¼ in. thick and heavier	1.60@2.60	2.00	3.34	4.15	3.25	3.10	3.30

RIVETS—The following quotations are per 100 lb.:

STRUCTURAL

	Pittsburgh Mill	Warehouse: New York, Dec. 3	New York, One Yr. Ago	Chicago	St. Louis	San Francisco	Dallas
½ in.	$2.60	$4.50	$3.75	$3.50	$3.65	$5.00	$4.75
CONE HEAD BOILER							
½ in.	2.90	$4.70	$3.85	$3.70	$4.20	$5.20	$5.00
⅝ and ¾	3.05	4.85	4.01	3.80	4.45	5.35	5.15
⅞ and 1	3.30	5.10	4.25	4.05	4.60	5.60	5.50

NAILS—The following quotations are per keg from warehouse:

	Pittsburgh Mill	Birmingham	Chicago	San Francisco	Dallas	St. Louis	Montreal
Wire	$2.65	$2.85	$3.15	$3.50	*$4.25*	$2.93	$4.95
Cut	*2.80*	2.90	....	5.30	5.00	3.13	5.00

SHIP SPIKES—Current prices per 100 lb.:

In.	San Francisco: Galv.	San Francisco: Black	Seattle Black
½	$7.50	$5.75	$7.75
⅝	7.05	5.30	5.65
¾	6.90	5.15	5.50

Pittsburgh base in lots of 200 kegs or more, $3.25.

PREPARED ROOFINGS—Slate-surfaced roofing in rolls of 108 sq.ft. costs $2.00@$2.75 per roll to contractors in carload lots f.o.b. New York.

Single shingles, slate finish, cost $7.00 per square (sufficient to cover 100 sq.ft.) in carload lots, f.o.b. New York. Strip shingles (4 in 1) f.o.b. New York, in carload lots to contractors, $5.00 per square.

ROOFING MATERIALS—Prices f.o.b. New York, to contractors in carload lots:

Tar felt (14 lb. per square of 100 sq.ft.) per ton	$70.00
Asphalt roofing (in barrels) per ton	25.00
Asphalt felt, per ton	75.00

WINDOW GLASS—United inches, 25, bracket size 6x8 to 10x15, single thickness "AA," 82 per cent; "A," 87 per cent; "B," 88 per cent. Double thickness "AA," 82 per cent; "A," 88 per cent; "B," 89 per cent discount from jobbers list at New York warehouses.

SHEETS—Quotations are per 100 lb. in various cities from warehouse also the base quotations from mill:

Blue Annealed	Pittsburgh Large Mill Lots	St. Louis	Chicago	San Francisco	New York
No. 10	2.40@2.50	$3.60	$3.50	$3.85	$3.89
No. 12	2.45@2.55	3.65	3.55	3.90	3.94
No. 14	2.50@2.60	3.70	3.60	3.95	3.99
No. 16	2.60@2.70	3.80	3.70	4.05	4.09
Black					
*Nos. 18 to 20	3.05@3.15	4.40	3.90	4.60	4.15
*Nos. 22 to 24	3.10@3.20	4.45	3.95	4.65	4.20
*Nos. 26 and 27	3.15@3.25	4.50	4.00	4.70	4.25
*No. 28	3.25@3.35	4.60	4.10	4.80	4.35
Galvanized					
No. 10	3.50@3.60	4.70	4.25	5.00	4.35
Nos. 12 to 14	3.60@3.70	4.80	4.35	5.10	4.45
No. 16	3.75@3.85	.....	4.50	5.25	4.60
Nos. 18 to 20	3.90@4.00	5.10	4.65	5.40	4.75
Nos. 22 to 24	4.05@4.15	5.25	4.80	5.55	4.90
*Nos. 26 and 27	4.20@4.30	5.40	4.95	5.70	5.05
*No. 28	4.50@4.60	5.70	5.25	6.00	5.35

* For painted corrugated sheets add 30c. per 1,000 lb. for 5 to 28 gage; 25c. for 19 to 24 gages; for galvanized corrugated sheets add 15c., all gages.

LINSEED OIL—These prices are per gallon:

	New York: Dec. 3	New York: One Year Ago	Chicago: Dec. 3	Chicago: One Year Ago
Raw in barrels (5 bbl. lots)	*$0.99*	$1.11	$0.99	$1.05

E. N.-R. Prices of Construction Materials

WHITE AND RED LEAD—Per 100-lb. keg, base price, f.o.b. New York:

	Dry		In Oil	
	Dec. 3	1 Yr. Ago	Dec. 3	1 Yr. Ago
Red	*$15.25*	$15.25	*$16.75*	$16.75
White	*15.25*	15.25	*15.25*	15.25

Lumber

Prices wholesale, per M. ft. b.m., to dealers in carload lots, f.o.b.

San Francisco—Prices of rough Douglas fir No. 1 common, in carload lots to dealers at yards. To contractors, $2 per M. ft. additional.

	6-8 and 12 Ft.	10-16-18 and 20 Ft.	22 and 24 Ft.	25 to 32 Ft.
3x3 and 4	$26.00	$27.00	$28.00	$31.00
3x6 and 8	26.00	27.00	28.00	31.00
4x4-6 and 8	26.00	27.00	28.00	31.00
3x10 and 12	26.00	27.00	28.00	31.00
3x14	30.00	30.00	32.00	34.00
4x10 and 12	26.00	27.00	28.00	31.00
4x14	30.00	30.00	32.00	34.00

	24 Ft. and Under	25 to 32 Ft.	33 to 40 Ft.
6x10	$28.00	$30.00	$32.00
6x14	34.00	36.00	38.00
8x10	28.00	30.00	32.00
8x14	34.00	36.00	38.00

New York and Chicago—Wholesale prices to dealers of long leaf yellow pine.

	New York		Chicago	
	20 Ft. and Under	22-24 Ft.	20 Ft. and Under	22-24 Ft.
3x4 to 8x8	$48.00	$49.00	*$42.00*	$43.00
3x10 to 10x10	52.00	53.00	**47.50**	**48.50**
3x12 to 12x12	56.00	57.00	**57.00**	**58.00**
3x14 to 14x14	64.00	65.00	**61.50**	**62.50**
3x16 to 16x16	70.00	71.00	69.50	70.50

New York—Wholesale price to dealers; to contractors, delivered from lighters or cars to job, $5@$10 additional. Short leaf pine costs $3 per M. less.

Over 24 ft.—Add $1 for each additional 2 ft. in length up to 32 ft. for sizes 12x12 and under; for sizes over 12x12 add $2; for merchantable add $2 to sizes 10x10 and under.

Other Cities

	8x8-In. x 20 Ft. and Under				12x12-In. 20 Ft. and Under	
	P.	Fir*	Hemlock	Spruce	P.	Fir*
Boston	*$50.00*	$48.00†	$51.00	$50.00	$60.00	$58.00†
Seattle	.....	*23.00*	.....	.....	.....	25.00
New Orleans	*41.00*	.....	.....	.....	**41.00**	.....
Baltimore	32.50	49.25	53.00	60.00	38.00	49.75
Cincinnati	37.00	73.00	73.00	85.00	48.00	77.00
Montreal	50.00	58.00	.....	.....	60.00	65.00
Los Angeles	.....	37.00	.....	.....	.....	38.00
Denver	.....	**32.75**	33.75	33.75	.....	*32.75*
Minneapolis	*42.00*	**36.75**	35.00	.....	44.50	**36.75**
Atlanta	31.00	.....	.....	.....	34.00	.....
Dallas	**60.00**	.....	.....	.....	**56.00**	.....
Kansas City, Mo.	**44.50**	40.75	.....	.....	**59.50**	41.75
Birmingham	32.00	.....	.....	.....	34.00	.....
Philadelphia	56.00	34.00	37.00	40.00	67.00	34.00
Detroit	44.75	50.75	.....	.....	54.75	50.75
St. Louis	41.00	.....	.....	.....	53.00	.....

	1-in. Rough, 10 In. x 16 Ft. and Under			2-In. T. and Gr. 10 In. x 16 Ft.	
	P.	Fir*	Hemlock	P.	Fir*
Boston	*$45.00*	$42.00†	$45.00	*$50.00*	$48.00†
Seattle	.....	20.00	.....	.....	22.00
New Orleans	*80.00*	.....	.....	*40.00*	.....
Baltimore	55.00	44.00	44.00	34.00	50.00
Cincinnati	70.00	79.00	75.00	38.00	85.00
Montreal	56.00	50.00	45.00	45.00	45.00
Los Angeles	.....	37.00	.....	.....	.....
Denver	.....	**34.25**	29.25	.....	**32.25**
Minneapolis	*42.50*	*34.75*	34.75	38.00	*33.25*
Atlanta	18.00	.....	.....	28.00	.....
Dallas	*52.00*	.....	.....	56.00	.....
Kansas City, Mo.	*42.25*	*37.75*	.....	**43.75**	**36.75**
Birmingham	20.00	.....	.....	35.00	.....
Philadelphia	34.00	33.00	36.00	54.00	34.00
Detroit	37.25	37.50	.....	44.00	41.75
St. Louis	43.00	.....	.....	29.50	.....

Birmingham—Quotes carload lots, f.o.b. sidings; $4.00 additional per M. ft. to contractors.
Boston and Cincinnati—Prices to contractors in carload lots, f.o.b.
Denver—Quotes dealers price to contractors on large projects.
St. Louis—Wholesale price to contractors, f.o.b. cars, $2 per M.ft. additional.
Seattle—Price to contractors, delivered.
Dallas—Wholesale to contractors, $10 per M.ft. additional.
*Douglas fir. †Prime.

PILES—Prices per lineal foot, pine piles with bark on, f.o.b. New York.

Diameters	Points	Length	Barge	Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.14½	$0.18½
12 in.—2 ft. from butt	6 in.	50 to 59 ft.	.19	.23½
12 in.—2 ft. from butt	6 in.	60 to 69 ft.	.21½	.25½
14 in.—2 ft. from butt	6 in.	50 to 69 ft.	.25½	.34
14 in.—2 ft. from butt	6 in.	70 to 79 ft.	.27½	.36½
14 in.—2 ft. from butt	5 in.	80 to 89 ft.	.35	.41

Miscellaneous

STEEL SHEETPILING—The following price is base per 100 lb. f.o.b. Pittsburgh, with a comparison of a month and a year ago:

Dec. 3	One Month Ago	One Year Ago
$2.25@$2.30	$2.25@$2.30	$1.95@2.05

WIRE ROPE—Discounts from list price on regular grades of bright and galvanized are as follows:

	Eastern Territory New York and East of Missouri River
Plow steel round strand rope	35%
Special steel round strand rope	30%
Cast steel round strand rope	20%
Round strand iron and iron tiller	5%
Galvanized steel rigging and guy rope	7½%
Galvanized iron rigging and guy rope	+12½%

California, Oregon, Nevada and Washington: Discount 5 points less than discount for Eastern territory.
Wyoming, New Mexico and Colorado: Discount 5 points less than discount for Eastern territory.
Arizona: Discount 10 points less than discount for Eastern territory.
Montana, Idaho and Utah: Discount 10 points less than discount for Eastern territory.
North Dakota, Nebraska, Kansas, Oklahoma and Texas: Discount 5 points less than discount for Eastern territory.

MANILA ROPE—For rope smaller than ¾-in. the price is ½ to 2c. extra; while for quantities amounting to less than 600 ft., there is an extra charge of 1c. The number of feet per pound for the various sizes is as follows: ½-in., 8 ft.; ⅝-in., 6; ¾-in., 4½; 1-in., 3½; 1¼-in., 2 ft. 10 in.; 1½-in., 2 ft. 4 in. Following is price per pound for ½-in. and larger, in 1200-ft. coils:

Boston	$0.19@.24	New Orleans	$0.24½
New York	.26	Los Angeles	.24½
Chicago	.24½	Seattle	.24
Minneapolis	.26½	St. Louis	.24½
San Francisco	.24	Montreal	.16
Atlanta	**.34**	Detroit	.26
Denver	*.27*	Baltimore	.18
Cincinnati	.21	Kansas City	*.21*
Dallas	.31	Birmingham	.30@.31
Philadelphia	.26		

EXPLOSIVES—Price per pound of dynamite in small lots:

	Gelatin 40%	Gelatin 60%
New York	$0.27	$0.295
Boston	.225	.25
Kansas City	*.2025*	*.2225*
Seattle	.165	.19
Chicago	.22	.245
Minneapolis	.1917	.2123
St. Louis	.22	.245
Denver	.2025	.2275
Dallas	.225	.302
Los Angeles	.1875	.2125
Atlanta	.23	.255
Baltimore	.22	.23
Cincinnati	.22	.245
Montreal	.195	.235
Birmingham	.23	.255
New Orleans	.233	.26
San Francisco	.1625	.1925
Philadelphia	.215	.24

CHEMICALS—Water and sewage treatment chemicals, spot shipments in carload lots, f.o.b. works:

Sulphate of aluminum, in bags, per 100 lb	$1.40@1.45
Sulphate of copper, in bbl., per 100 lb	4.50@4.60
Soda ash, 58%, in bags, per 100 lb	1.38@1.55
Chlorine, liquid, tanks, per lb	.04@.04½
Hypochlorite of lime (bleaching powder) in drums, per 100 lb	2.00@2.10

FREIGHT RATES—On finished steel products in the Pittsburgh district, including plates, structural shapes, merchant steel, bars, pipe fittings, plain and galvanized wire nails, rivets, spikes, bolts, flat sheets (except planished), chains, etc., the following freight rates are effective in cents per 100 lb., in carloads of 36,000 lb.:

Atlanta	$0.58	Detroit	$0.29
Baltimore	.31	Kansas City	.735
Birmingham	.58	New Orleans	.67
Boston	.365	New York	.34
Buffalo	.265	Pacific Coast (all rail)	1.15*
Chicago	.34	Philadelphia	.32
Cincinnati	.29	St. Louis	.43
Cleveland	.19	St. Paul	.60
Denver	1.15*		

* Minimum carload, 50,000 lb., structural steel only; 80,000 lb., for other iron or steel products.